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RADIOLOGY RESIDENTS' PERCEPTIONS OF BREAST IMAGING PROCEDURAL TRAINING AND COMPETENCY: A CROSS-SECTIONAL STUDY IN SAUDI ARABIA

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ABSTRACT

Background: The increasing demand for breast imaging services, coupled with a shortage of subspecialized radiologists, highlights the need for radiology residents to achieve adequate competency in breast imaging procedures. This study evaluated residents' perceptions of their training exposure, need for additional training, confidence in performing procedures after residency, and the relationships among these factors.

Methods: A cross-sectional survey was conducted among 85 graduating radiology residents from multiple training centers in Saudi Arabia who completed their final examinations in Jeddah. A structured questionnaire assessed residents' training experience—defined as observation, supervised performance, and independent performance—in five breast imaging procedures: ultrasound-guided fine-needle aspiration biopsy, ultrasound-guided core biopsy, stereotactic core biopsy, needle-wire localization, and galactography. Perceived need for further training and confidence in future practice were also evaluated.

Results: Training exposure varied substantially across procedures. The proportion of residents reporting ≥5 observations ranged from 14.5% to 73.4%, supervised performance from 10.8% to 41.6%, and independent performance from 11.0% to 26.3%. The perceived need for additional training was high (65.9%–94.7%), whereas confidence in performing procedures ranged from 18.2% to 68.8%. Significant positive correlations were observed between procedural exposure (observation and performance) and confidence ($p < 0.05$), while no significant association was found between perceived need for additional training and confidence.

Conclusion: Radiology residents report limited exposure to several breast imaging procedures, which is associated with lower confidence in independent practice. These findings underscore the need for enhanced procedural training, including increased hands-on experience and structured competency-based curricula, to better prepare residents for clinical practice.

KEYWORDS: breast imaging; clinical competence; medical education; procedural skills; radiology residency; Saudi Arabia

INTRODUCTION

As public health awareness increases and organized screening programs expand, breast imaging remains a cornerstone of breast cancer control strategies worldwide (International Agency for Research on Cancer; World Health Organization). Therefore, there is a growing need for well-trained radiologists to accurately interpret screening mammograms and perform diagnostic work-ups, including image-guided interventions (American College of Radiology, 2023). For example, percutaneous image-guided biopsies are increasingly used as a minimally invasive alternative to surgical biopsy for evaluating suspicious breast lesions (National Comprehensive Cancer Network). This shift is largely driven by advantages such as reduced morbidity, lower cost, shorter recovery time, and high diagnostic accuracy for both patients and clinicians, with core needle biopsy demonstrating sensitivity of approximately 85–97% and specificity approaching 100% in recent studies (Lu et al., 2021).

However, there is a recognized shortage of adequately trained breast imaging radiologists globally, including in regions such as the Middle East, where workforce distribution and subspecialty training opportunities remain uneven (Royal College of Radiologists, 2021; Alsalah, 2025). This shortage persists despite increasing demand for breast imaging services. One strategy to mitigate this gap is to ensure that radiology residents achieve adequate competency in breast imaging procedures during residency training. However, training sufficient numbers of residents to master these procedures remains challenging. Residents must be exposed to a wide range of procedures and have sufficient time allocated to dedicated breast imaging rotations. Effective training also requires structured curricula, supervised hands-on experience, and standardized assessment frameworks, as variability in training exposure and supervision has been shown to significantly affect residents' competency development and readiness for independent practice (Zaki-Metias et al., 2026). Despite its importance, limited evidence exists regarding the extent and nature of radiology residents' training in breast imaging procedural skills. Such information is essential for informing both educators and trainees and for optimizing curricula that respond

to evolving healthcare needs. Therefore, the purpose of this study is to provide an in-depth examination of radiology residents' training in breast imaging procedures.
The following research questions (RQs) are addressed: What are radiology residents' perceptions regarding (1) breast imaging procedural training during residency, (2) the need for additional training after residency, and (3) confidence in performing these procedures after residency? Additionally, (4) what are the relationships among these perceptions? Addressing these questions will provide insight into how training experiences relate to confidence and perceived competency, thereby informing targeted improvements in residency training programs.

MATERIALS AND METHODS

Sample and designs

Survey data were collected from 85 senior radiology residents who graduated from diverse institutes across Saudi Arabia. Residents were recruited on-site and invited to complete a survey when they took their final exams in Jeddah, Saudi Arabia. A graduating senior resident was defined as one who was in his/her 4th year of a radiology residency program after completion of the clinical internship year. In other words, residents were at postgraduate medical school year 5. A multi-item survey was handed out by a research assistant to evaluate residents' experiences in breast imaging procedures training during their residency, their need for additional training after residency, and their confidence in performing breast imaging procedures in the future.

Measures

Breast imaging procedures training during residency. Residents were asked about their (a) observation, (b) supervised performance and (c) unsupervised performance of five breast imaging procedures (ultrasound guided FNA biopsy, ultrasound guided core biopsy, stereotactic core biopsy, needle-wire localization, Galactogram) during their residency. Responses were recorded as 0 = < 5 times and 1 = > 5 times. For the correlation analysis, three scales were created by adding the responses to the five corresponding procedures for observation, supervised performance, and unsupervised performance. Higher scores indicate greater training.
Need for additional breast imaging procedures training after residency. Residents were asked whether they needed additional training in the five breast imaging procedures after completing their residency. Responses were 0 = no further training needed and 1 = further training needed. The need additional training scale was created by adding the responses to the five procedures. Higher scores indicate greater need for additional training.
Confidence in performing breast imaging procedures after residency. Residents were asked whether they were confident (0 = not confident, 1 = confident) in performing each of the five breast imaging procedures after completing their residency. The confidence in performing future breast imaging procedures scale was created by adding the responses to the five procedures. Higher scores indicate greater performance confidence.
Resident characteristics. Residents provided information on their gender (0 = male, 1 = female) and age (0 = under 30 years, 1 = over 30 years). Residents further indicated whether they had prior radiology experience (0 = no, 1 = yes), the number of weeks they spent in full-time breast imaging rotation during their residency (1 = < 4 weeks, 2 = 4-8 weeks, 3 = > 8 weeks), and estimated the percentage of their future practice that will be related to breast imaging procedures (1 = < 10%, 2 = 25-50%, 3 = > 50%). Residents also noted at which institute they completed their breast imaging rotation (1 = King Abdulaziz University Hospital, 2 = National Guard, 3 = Military Hospital, 4 = King Faisal Specialist Hospital, 5 = Other Institute).

Data analysis

Descriptive statistics were calculated for all study variables to examine the characteristics of radiology residents and to answer the first three research questions. Correlation analysis using Pearson correlation coefficients was performed to answer the fourth research question. All data were analyzed using SPSS 17 (SPSS Inc., Chicago, IL).

RESULTS

Radiology residents' demographics

As seen in Table 1, the majority of residents was male (62.4%), under 31 years of age (60%), and did not have any radiology experience prior to starting their residency program (84.7%). Additionally, 70.5% of residents had more than 8 weeks experience in full-time breast imaging rotation and 57.5% estimated that the percentage of their future breast-related practice will be less than 10%. Residents came from all areas of Saudi Arabia as indicated in the diverse institutes at which they completed their breast imaging rotation including the National Guard (17.6%), King Faisal Specialist Hospital (14.1%), King Abdulaziz University Hospital (8.2%), Military Hospital (5.9%), and "other" institutes (54.1%).

RQ1: What are radiology residents' perceptions regarding breast imaging procedures training during residency?
Table 2 presents the findings on the breast imaging procedures training observed and performed both supervised and unsupervised during residency. Procedures that were observed 5 or more times in order from highest to lowest observation were ultrasound guided FNA biopsy (73.4%), ultrasound guided core biopsy (63.6%), stereotactic

core biopsy (28.2%), needle-wire localization (23.1%), and Galactogram (14.5%). Procedures that were performed with supervision 5 or more times in order from highest to lowest performance were ultrasound guided FNA biopsy (41.6%), ultrasound guided core biopsy (38.2%), needle-wire localization (16.0%), stereotactic core biopsy (14.7%), and Galactogram (10.8%). Procedures that were performed without supervision 5 or more times in order from highest to lowest unsupervised performance were ultrasound guided FNA biopsy (26.3%), ultrasound guided core biopsy (21.1%), needle-wire localization (16.0%), stereotactic core biopsy (14.9%), and Galactogram (11.0%).

RQ2: What are radiology residents' perceptions regarding the need for additional training after residency?

As shown in Table 3, procedures that required further training in order from highest to lowest training need after residency were stereotactic core biopsy (94.7%), needle-wire localization (92.1%) and Galactogram (92.1%), ultrasound guided core biopsy (79.7%), and ultrasound guided FNA biopsy (65.9%).

RQ3: What are radiology residents' perceptions regarding their confidence in performing breast imaging procedures after residency?

As indicated in Table 3, confidence in performing procedures in order from highest to lowest confidence were ultrasound guided FNA biopsy (68.8%), ultrasound guided core biopsy (62.3%), needle-wire localization (28.6%), stereotactic core biopsy (22.1%), and Galactogram (18.2%).

RQ4: What is the relationship among these breast imaging procedures perceptions?

Table 4 shows both the descriptive statistics and the intercorrelations among all resident perceptions. Residents' reported a mean of 2.04 observations of breast imaging procedures, 1.22 supervised performance, .88 unsupervised performance, 4.32 additional training needed, and 2.00 performance confidence.

Further, residents who reported greater observations of breast imaging procedures reported greater performance of these procedures with supervision ($r = .62$) and without supervision ($r = .43$) as well as reported greater confidence in future performance of these procedures ($r = .52$). Residents who reported greater supervised performance also reported greater unsupervised performance ($r = .71$) and greater performance confidence ($r = .59$). Finally, residents who reported greater unsupervised performance also reported greater performance confidence ($r = .55$). In contrast, residents' perceptions of additional training needed in breast imaging procedures were not significantly ($p > .05$) related to any of the other training aspects.

DISCUSSION

The purpose of this study was to provide an in-depth examination of radiology residents' training and subsequent preparedness in breast imaging procedures. Although prior literature indicates that core breast imaging procedural skills are incorporated into radiology residency training curricula, variability in exposure and competency remains a persistent concern (Omofoye et al., 2022; ten Cate et al., 2024; Zaki-Metias et al., 2026). Findings from this study indicate that a substantial proportion of graduating residents from Saudi radiology programs do not observe or perform a wide range of procedures at a level sufficient to achieve confidence in independent practice. These findings are consistent with regional evidence demonstrating workforce and subspecialty training gaps in Saudi Arabia and the broader Middle East (Alsalah, 2025; Manchikanti et al., 2025).

Recent national data from Saudi Arabia indicate a marked imbalance in radiology subspecialties, with breast imaging representing only a small proportion of practicing radiologists despite increasing demand for oncologic imaging services (Alsalah, 2025). This shortage is further compounded by the geographic maldistribution of radiologists, with a concentration in major urban centers, thereby limiting training opportunities and procedural exposure in other regions (Alsalah, 2025). Similar workforce challenges have been reported internationally, where increasing imaging demand continues to outpace the availability of trained radiologists, particularly in subspecialties such as breast imaging (Alturki et al., 2019).

Breast Imaging Procedures Training

Observation and performance—both with and without supervision—were reported to be limited, particularly for more complex procedures such as stereotactic core biopsy, needle-wire localization, and galactography, compared with ultrasound-guided techniques. These findings are consistent with studies demonstrating variability in procedural exposure and case volume among radiology trainees (ten Cate et al., 2024; Zaki-Metias, et al., 2026). In Saudi Arabia, training experiences may also vary depending on institutional resources, case volume, and access to subspecialty services, which can influence competency development and confidence among residents (Alturki et al., 2019).

Importantly, increased exposure through observation and hands-on experience was positively associated with residents' confidence in performing these procedures independently, supporting competency-based education models that emphasize experiential learning and progressive autonomy (Misra et al., 2021; ten Cate et al., 2024). In contrast, perceived need for additional training was less strongly associated with confidence, suggesting that objective procedural exposure may be more influential than subjective perceptions of preparedness.

Training in procedural skills is widely recognized to involve three key components: didactic instruction, supervised hands-on practice, and gradual transition to independent performance within structured competency-based frameworks (Misra et al., 2021; ten Cate et al., 2024). Therefore, training programs should emphasize all three components and address current gaps by refining curricula to ensure adequate exposure to essential breast imaging procedures. Program directors should regularly evaluate which skills are sufficiently taught, assess both confidence and competence, and implement targeted improvements in training structure.

Furthermore, program leadership must define the procedural competencies expected of residents and ensure that trainees receive adequate exposure and assessment to achieve these competencies. Given the uneven distribution of subspecialty expertise in Saudi Arabia, restructuring clinical rotations—such as incorporating rotations in high-volume tertiary or cancer centers—may be necessary to optimize procedural experience. Even among residents reporting higher procedural volumes, limited rotation duration may hinder the development of confidence and technical proficiency.

Providing a strong foundation early in training has traditionally been central to skills acquisition; however, the structure and delivery of training vary across institutions. Clinical competence is context-dependent and influenced by factors such as resource availability, healthcare infrastructure, and population needs. In rapidly evolving healthcare systems such as those in Saudi Arabia and the Gulf region, maintaining flexible and comprehensive training curricula is essential to meet future workforce demands.

Limitations

Several limitations should be considered when interpreting these findings. This study relied on residents' self-reported perceptions of training exposure and confidence rather than objective measures of competence. Self-reporting may introduce recall bias or inaccuracies in estimating procedural experience. Additionally, procedural competence encompasses multiple domains—including technical skill, clinical judgment, and professionalism—that may not be fully captured through survey data. As a cross-sectional study, causal relationships cannot be established. Nevertheless, perceived confidence remains clinically relevant, as it may influence future practice patterns and reflect underlying training adequacy.

Recommendations for future research

Future studies should investigate gender-based differences in anticipated clinical practice patterns, as supplementary analyses using chi-square tests (not included in this manuscript) suggested that female residents are more likely than male residents to anticipate a greater involvement in breast imaging–related practice. Further research is needed to explore the factors underlying these differences and their implications for workforce planning and training program design.

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Table 1. Characteristics of radiology residents.

Variable		Frequency N (%)
Gender	Male	53 (62.4)
	Female	32 (37.6)
Age	< 30 years	51 (60.0)
	> 30 years	34 (40.0)
Radiology experience prior to residency	Yes	13 (15.3)
	No	72 (84.7)
Number of weeks spent in full-time breast-imaging rotation during residency	< 4 weeks	6 (7.7)
	4-8 weeks	17 (21.8)
	>8 weeks	55 (70.5)
Estimated percentage of future breast-related practice	<10%	42 (57.5)
	25%-50%	26 (35.6)
	>50%	5 (6.8)
Institute at which breast-imaging rotation was completed	King Abdulaziz University Hospital	7 (8.2)
	National Guard	15 (17.6)
	Military Hospital	5 (5.9)
	King Faisal Specialist Hospital	12 (14.1)
	Other institute	46 (54.1)

Table 2. Breast imaging procedures training during residency.

Variable		<5 times N (%)	>5 times N (%)
Observed procedures	Ultrasound Guided FNA Biopsy	21 (26.6)	58 (73.4)
	Ultrasound Guided Core Biopsy	28 (36.4)	49 (63.6)
	Stereotactic Core Biopsy	56 (71.8)	22 (28.2)
	Needle-Wire Localization	60 (76.9)	18 (23.1)
	Galactogram	65 (85.5)	11 (14.5)
Performed procedures with staff supervision	Ultrasound Guided FNA Biopsy	45 (58.4)	32 (41.6)
	Ultrasound Guided Core Biopsy	47 (61.8)	29 (38.2)
	Stereotactic Core Biopsy	64 (85.3)	11 (14.7)
	Needle-Wire Localization	63 (84.0)	12 (16.0)
	Galactogram	66 (89.2)	8 (10.8)
Performed Procedures without Staff Supervision	Ultrasound Guided FNA Biopsy	56 (73.7)	20 (26.3)
	Ultrasound Guided Core Biopsy	60 (78.9)	16 (21.1)
	Stereotactic Core Biopsy	63 (85.1)	11 (14.9)
	Needle-Wire Localization	63 (84.0)	12 (16.0)
	Galactogram	65 (89.0)	8 (11.0)

Table 3. After residency additional training needed and confidence in future breast imaging procedures performance.

Variable		No N (%)	Yes N (%)
Additional Training Needed	Ultrasound Guided FNA Biopsy	19 (25.3)	56 (65.9)
	Ultrasound Guided Core Biopsy	15 (20.3)	59 (79.7)
	Stereotactic Core Biopsy	4 (5.3)	72 (94.7)
	Needle-Wire Localization	6 (7.9)	76 (92.1)
	Galactogram	6 (7.9)	70 (92.1)
Confident to Perform Procedure in the Future	Ultrasound Guided FNA Biopsy	24 (31.2)	53 (68.8)
	Ultrasound Guided Core Biopsy	29 (37.7)	48 (62.3)
	Stereotactic Core Biopsy	60 (77.9)	17 (22.1)
	Needle-Wire Localization	55 (71.4)	22 (28.6)
	Galactogram	63 (81.8)	14 (18.2)

Table 4. Descriptive statistics and relationships among residents' perceptions of breast imaging procedures.

Variables	M	SD	1	2	3	4	5
1. Observation of procedures	2.04	1.53	1.00	0.62***	0.43***	0.02	0.52***
2. Supervised performance of procedures	1.22	1.58		1.00	0.71***	-0.01	0.59***
3. Unsupervised performance of procedures	0.88	1.61			1.00	-0.02	0.55***
4. Additional training needed after residency	4.32	1.29				1.00	0.12
5. Confidence in future performance of procedures	2.00	1.53					1.00

Note. Scale ranged from 0-5 with higher scores indicating greater noted perceptions

***$p < .001$