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Comparing Breast Cancer Warning Sign Recognition and Simulator-Assessed Palpation Skills Between Reproductive-Age Women and Adolescent Girls

Amir Hesabi[1], Masumeh Ghazanfarpour[2], Sara Najibi[2], Maryam Memardoost[3], *Hediyeh Barkhordar[2]

[1]Department of Pediatrics, Clinical Research Development Center of Children's Hospital, Hormozgan University of Medical Sciences, Bandar Abbas, Iran. [2]Reproductive and Family Health Research Center, Kerman University of Medical Sciences, Kerman, Iran. [3]Student Research Committee, Kerman University of Medical Sciences, Kerman, Iran.

Abstract

Background: Recognition of breast cancer warning signs and practical palpation are distinct educational outcomes. Assessing both may reveal needs overlooked by knowledge assessments alone. This study compared breast cancer warning-sign recognition, simulator-assessed palpation skills, and referral-related decision-making between reproductive-age women and adolescent girls.

Materials and Methods: This quasi-experimental comparative study recruited 30 employed reproductive-age women (18–45 years) and 30 adolescent students (15–18 years) through multistage sampling in Kerman, Iran. Both groups received 30-minute training using a three-dimensional warning-sign display and a locally developed silicone breast phantom containing eight concealed resin nodules. Post-intervention assessments evaluated warning-sign recognition, recognition of suspicious lump characteristics, nodule detection, and referral-related decision-making. Between-group comparisons used independent-samples t-tests and chi-square or Fisher's exact tests in SPSS version 26.

Results: Among 60 participants, reproductive-age women showed higher recognition of nipple discharge, breast erythema, sudden unilateral breast enlargement, and peau d'orange than adolescent girls (all $p < 0.05$), and more frequently identified lump characteristics suggestive of malignancy (76.7% vs. 40.0%; $p = 0.004$). Immediate medical referral was selected by 76.7% of women and 33.3% of girls; the overall referral-response distribution differed significantly between groups ($p = 0.001$). Mean nodule detection scores were 3.20 ± 2.55 and 2.73 ± 2.57 out of eight, respectively, with no statistically significant between-group difference (mean difference = 0.47; 95% CI: −0.86 to 1.79; $p = 0.483$).

Conclusion: Reproductive-age women demonstrated better warning-sign recognition and referral-related responses than adolescent girls, whereas both groups showed limited simulator-assessed nodule detection. These findings highlight distinct educational needs. Controlled studies are needed to evaluate simulator effectiveness, learning gains, long-term skill retention, and effects on real-world help-seeking behavior.

Key Words: Breast Neoplasms; Health Education; Simulation Training; Breast Awareness; Palpation.

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Corresponding Author:

Hossein Ali Kharazmi, Faculty of Medicine, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.

Email: kharazmi55403@gmail.com

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1- INTRODUCTION

Breast cancer is the most commonly diagnosed cancer among women worldwide and a leading cause of cancer-related mortality in this population. In 2022, it accounted for approximately 2.3 million new cases and 666,000 deaths among women, representing 23.8% of new cancer cases and 15.4% of cancer deaths in this population (1, 2). Although breast cancer is more commonly diagnosed in middle and older adulthood, age at diagnosis and stage at presentation vary substantially across settings. Differences in access to early detection, diagnostic services, and treatment contribute to disparities in breast cancer outcomes (3).

Early recognition of warning signs and timely help-seeking are therefore central components of early diagnosis, particularly in settings where organized mammographic screening is limited (2, 4). Adolescence is an important period for establishing health-related knowledge, attitudes, and behaviors. Breast health education during this period can introduce recognition of concerning changes, appropriate examination practices, and timely help-seeking (5, 6).

Breast awareness—familiarity with an individual's usual breast appearance and texture and recognition of new or unexplained changes—should be distinguished from breast self-examination (BSE) performed as a scheduled screening practice. Educational activities should complement, rather than replace, appropriate clinical assessment, diagnostic evaluation, and established screening pathways (7–9). Improving symptom recognition, addressing misconceptions, and developing appropriate responses to breast changes remain important educational objectives (10–12).

Existing research indicates that knowledge of breast cancer symptoms and self-reported examination practices are often inadequate among adolescent girls and young women. Studies have reported gaps in breast cancer knowledge, limited examination practices, and uncertainty about examination technique (10, 13–15). These findings identify a need for education that addresses both recognition and appropriate responses to concerning changes. Reviews and intervention studies suggest that school- and community-based education can improve breast cancer knowledge and address barriers to help-seeking, although educational methods and outcome measures vary (11, 16). Knowledge, self-reported behavior, and observed practical performance should therefore be considered distinct outcomes rather than interchangeable indicators of competence.

Instruction without supervised practice provides limited opportunities to observe palpation technique and deliver individualized feedback. Physical simulators and breast phantoms offer a controlled environment for practical learning and assessment. Given the methodological variation identified in school-level educational research, standardized assessment of practical outcomes warrants further investigation (11). Simulation-based education has been used to improve breast cancer awareness and BSE-related skills among adult women, supporting further evaluation of supervised practice and feedback (17).

However, comparative evidence concerning adolescent girls and reproductive-age women remains limited. These groups may differ in educational experience, reproductive history, exposure to breast health information, and contact with healthcare services. Such differences may influence symptom recognition and referral-related responses but should not be assumed to correspond to differences in tactile detection. Assessing recognition, practical performance, and referral-related decisions separately may help identify

educational needs that knowledge-based questionnaires alone do not capture.

Therefore, this study compared breast cancer warning-sign recognition, simulator-assessed palpation performance, and referral-related decision-making between reproductive-age women and adolescent female students after a standardized educational session. The session incorporated a three-dimensional warning-sign display and a locally developed silicone breast phantom containing eight concealed resin nodules. By assessing these complementary outcomes after the same instruction, the study aimed to characterize group-specific educational needs and inform age-appropriate breast health education. It was not designed to establish improvement from baseline or the effectiveness of the simulator relative to an alternative educational approach.

2- MATERIALS AND METHODS

2-1. Study Design and Setting

This quasi-experimental comparative study used a post-intervention-only assessment to compare two nonrandomized participant groups. It was conducted over approximately one month between November and December 2025 in Kerman, Iran. Recruitment, education, and assessment took place at the central administrative headquarters of Kerman University of Medical Sciences (KMU) and two urban comprehensive health centers affiliated with KMU.

The study compared breast cancer warning-sign recognition, simulator-assessed palpation performance, and referral-related decision-making between reproductive-age women and adolescent female students after the same standardized simulator-based educational session.

2-2. Participants and Sampling

A multistage recruitment strategy combined setting selection with convenience recruitment. For the reproductive-age group, the central administrative headquarters of KMU was selected as the recruitment setting. Eligible female employees aged 18–45 years were recruited through convenience sampling until 30 participants had been enrolled.

For the adolescent group, two urban comprehensive health centers were selected from the centers affiliated with KMU using simple random sampling by lottery. Eligible female students aged 15–18 years attending these centers, independently or with a family member, were approached consecutively and recruited through convenience sampling until 30 participants had been enrolled.

The random selection of health centers did not constitute random assignment of participants to study groups.

2-3. Sample Size

The sample size was calculated using G*Power version 3.1.9.7 for a two-sided comparison of two independent means, with simulator-assessed palpation performance as the planning outcome. Assuming a medium-to-large effect size, a significance level of 0.05, statistical power of 0.80, and equal group sizes, the minimum required sample size was estimated to be 30 participants per group (18). Accordingly, 60 participants were enrolled: 30 reproductive-age women and 30 adolescent female students.

2-4. Eligibility Criteria

2-4-1. Reproductive-Age Women

Inclusion criteria were:

- Age 18–45 years.
- Current employment in an administrative or staff position at the central headquarters of KMU.

- No personal history of breast tumors, breast malignancy, or breast surgery.
- Provision of written informed consent.

2-4-2. Adolescent Female Students

Inclusion criteria were:

- Age 15–18 years.
- Current school enrollment.
- Attendance at one of the selected comprehensive health centers.
- No personal history of breast pathology or breast surgery.
- Provision of the consent or assent required by the approved ethics protocol.

The selected age range falls within, but does not encompass, the WHO definition of adolescence as 10–19 years (19).

For participants younger than 18 years, written parental or legal guardian consent and adolescent assent were obtained. Participants aged 18 years provided their own written informed consent.

2-4-3. Exclusion Criteria

Participants were excluded for:

- Withdrawal from the study.
- Missing more than 20% of the written assessment items.
- Failure to complete the visual or tactile assessment.

2-5. Assessment Instruments and Simulator Components

Data were collected using a researcher-developed assessment package covering demographic and health background characteristics, warning-sign recognition, palpation performance, and referral-related decision-making.

2-5-1. Demographic and Health Background Questionnaire

The questionnaire collected information on age, educational attainment or field of study, marital status, occupational status, breastfeeding history, family history of breast cancer, and previous BSE training.

2-5-2. Visual Warning-Sign Recognition Assessment

A three-dimensional display board illustrated six breast changes selected for the educational and assessment activities, informed by breast cancer guidance (2, 8):

- Nipple discharge.
- Nipple retraction.
- Dilated superficial veins.
- Breast erythema or skin redness.
- Sudden unilateral breast enlargement.
- Peau d’orange.

Recognition of each sign was recorded as correct or incorrect using a standardized checklist. A separate item assessed recognition of lump characteristics suggestive of malignancy. These items assessed recognition rather than diagnostic accuracy.

2-5-3. Tactile Breast Phantom

A locally developed silicone breast phantom contained eight concealed resin nodules with spherical or irregular shapes and diameters ranging from 5 to 20 mm. Nodules were positioned at superficial and deeper levels to allow assessment of detection at different depths.

The palpation score was the number of correctly detected nodules, ranging from 0 to 8. Higher scores indicated detection of more embedded nodules; the score did not measure the ability to diagnose malignancy. The use of simulation for breast examination education was informed by previous research (17).

2-5-4. Referral-Related Decision-Making Assessment

A standardized hypothetical clinical scenario assessed participants' responses to a suspicious breast change. Responses were classified into four categories:

- Code 0: No action.
- Code 1: Immediate medical referral.
- Code 2: Delayed or non-urgent follow-up.
- Code 3: Inappropriate action.

Immediate medical referral was designated the appropriate response for the scenario, consistent with guidance emphasizing timely professional assessment of suspicious breast changes (4, 7, 8). The outcome measured a stated response to a hypothetical situation, not actual help-seeking behavior.

2-6. Validity and Reliability

A panel of 10 faculty members specializing in reproductive health, surgical oncology, and midwifery evaluated the face and content validity of the simulator components and assessment checklists. The content validity ratio (CVR) was 0.85, and the content validity index (CVI) was 0.92. Internal consistency of the assessment checklists was assessed using Cronbach's alpha ($\alpha = 0.84$). Inter-rater reliability was evaluated using Cohen's kappa ($\kappa = 0.88$) and the intraclass correlation coefficient (ICC = 0.91).

2-7. Educational Intervention

An experienced midwife delivered the same standardized educational protocol to both groups. Sessions were conducted individually or in groups of two to three participants in private rooms at the KMU headquarters and selected health centers.

Each session lasted approximately 30 minutes and combined instruction, visual demonstration, and supervised palpation practice. During the initial 15-minute component, the instructor introduced the six breast changes illustrated on the three-dimensional display and demonstrated breast palpation technique. Demonstration included use of the finger pads of the three middle fingers, overlapping circular movements, and light, medium, and deep pressure.

Participants subsequently practiced palpation under supervision using the breast phantom. The session also addressed appropriate help-seeking and timely medical evaluation of suspicious changes. Educational materials and the instructional sequence were the same for both groups.

The educational content was informed by breast cancer awareness and early-diagnosis guidance (2, 4, 7, 8), while the simulation component was informed by previous research (17).

2-8. Outcome Assessment

After the educational session, participants completed the same standardized assessment. Outcomes were:

1. Correct recognition of each of the six displayed breast changes.
2. Correct recognition of lump characteristics suggestive of malignancy.
3. Number of correctly detected phantom nodules, out of eight.
4. Distribution of responses to the referral-related clinical scenario.

These were post-intervention comparisons between the two participant groups. They did not measure change from baseline or the effect of simulation relative to another teaching method.

2-9. Statistical Analysis

Analyses were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages, and continuous variables

were summarized as means and standard deviations.

Normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Levene's test was used to assess homogeneity of variances before the independent-samples t-test. Mean nodule detection scores were compared between groups using an independent-samples t-test, with the mean difference and its 95% confidence interval reported. The difference was calculated as the mean score for reproductive-age women minus that for adolescent girls.

Pearson's chi-square tests without continuity correction were used for the seven binary recognition outcomes. The overall distribution of the four referral-response categories was compared using the two-sided Fisher–Freeman–Halton exact test because of small expected cell counts. The exact-test p-value applied to the overall response distribution, not to the immediate-referral category alone.

All tests were two-sided, and $p < 0.05$ was considered statistically significant. No adjustment was made for multiple comparisons.

2-10. Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee for Biomedical Research at Kerman University of Medical Sciences (approval number: IR.KMU.REC.1405.329).

Before enrollment, participants received information about the study objectives, procedures, duration, and anticipated risks or discomfort. Participation was voluntary, and participants could decline or withdraw without consequences for their education, employment, or access to healthcare.

Written informed consent was obtained from participants aged 18 years or older. For participants younger than 18 years, written parental or legal guardian consent and adolescent assent were obtained.

Educational and assessment sessions were conducted in private rooms. Participants were assigned coded identifiers, and personally identifying information was excluded from the analytical dataset. Access to identifiable records was restricted to authorized research personnel, and findings were reported in aggregate form.

3- RESULTS

3-1. Participant Characteristics

The study included 60 participants: 30 reproductive-age women and 30 adolescent girls. All adolescent participants were unmarried secondary school students, whereas most reproductive-age women were married. A history of breastfeeding was reported only among reproductive-age women, and a family history of breast cancer was uncommon in this group. Twenty participants in each group (66.7%) reported basic or limited previous breast self-examination training. Demographic and background characteristics are summarized in **Table 1**.

3-2. Recognition of Breast Cancer Warning Signs

Following the educational session, reproductive-age women demonstrated higher recognition rates than adolescent girls for nipple discharge (63.3% vs. 36.7%; $p = 0.039$), breast erythema (36.7% vs. 13.3%; $p = 0.037$), sudden unilateral breast enlargement (40.0% vs. 16.7%; $p = 0.045$), and peau d'orange (46.7% vs. 20.0%; $p = 0.028$). Recognition rates for nipple retraction (50.0% vs. 26.7%; $p = 0.063$) and dilated superficial veins (40.0% vs. 23.3%; $p = 0.165$) were also numerically higher among reproductive-age women, but these differences were not statistically significant.

Reproductive-age women more frequently identified lump characteristics suggestive of malignancy than adolescent girls (76.7% vs. 40.0%; p = 0.004). Item-level results are presented in **Table 2**.

3-3. Referral-Related Decision-Making

Immediate medical referral was selected by 23 reproductive-age women (76.7%) and 10 adolescent girls (33.3%). Delayed or non-urgent follow-up was selected by seven women (23.3%) and 14 girls (46.7%). Among adolescent girls, one participant (3.3%) selected no action and five (16.7%) selected an inappropriate action; no reproductive-age women selected either response.

The overall distribution of responses across the four categories differed significantly between groups (two-sided Fisher–Freeman–Halton exact test, p = 0.001; **Table 2**).

3-4. Simulator-Assessed Palpation Performance

The mean number of correctly detected nodules, out of eight embedded nodules, was 3.20 ± 2.55 among reproductive-age women and 2.73 ± 2.57 among adolescent girls. Although reproductive-age women had a numerically higher mean score, the between-group difference was not statistically significant (mean difference = 0.47; 95% CI: −0.86 to 1.79; t(58) = 0.705, p = 0.483). On average, both groups detected fewer than half of the embedded nodules. Simulator-assessed palpation results are presented in **Table 3**.

Table-1: Demographic and background characteristics of participants (n = 60).

Characteristic	Category	Reproductive-age women (n = 30), n (%)	Adolescent girls (n = 30), n (%)
Educational attainment	Below high school diploma	0(0.0%)	30(100.0%)
	High school diploma	2(6.7%)	0(0.0%)
	Bachelor's degree	11(36.7%)	0(0.0%)
	Other	17(56.7%)	0(0.0%)
Marital status	Unmarried	7(23.3%)	30(100.0%)
	Married	23(76.7%)	0(0.0%)
History of breastfeeding	Yes	18(60.0%)	0(0.0%)
	No	12(40.0%)	30(100.0%)
Family history of breast cancer	Yes	2(6.7%)	0(0.0%)
	No	26(86.7%)	30(100.0%)
	Unknown or not reported	2(6.7%)	0(0.0%)
Previous breast self-examination training	None	0(0.0%)	1(3.3%)

Characteristic	Category	Reproductive-age women (n = 30), n (%)	Adolescent girls (n = 30), n (%)
	Basic or limited	20(66.7%)	20(66.7%)
	Advanced	10(33.3%)	9(30.0%)

Note. Data are presented as n (%). Reproductive-age women were aged 18–45 years, and adolescent girls were aged 15–18 years.

Table-2: Post-intervention breast cancer warning-sign recognition and referral-related decision-making by study group.

Item or response category	Reproductive-age women (n = 30), n (%)	Adolescent girls (n = 30), n (%)	χ^2	df	P-value
Nipple discharge	19 (63.3)	11 (36.7)	4.267	1	0.039
Nipple retraction	15 (50.0)	8 (26.7)	3.455	1	0.063
Dilated superficial veins	12 (40.0)	7 (23.3)	1.926	1	0.165
Breast erythema	11 (36.7)	4 (13.3)	4.356	1	0.037
Sudden unilateral breast enlargement	12 (40.0)	5 (16.7)	4.022	1	0.045
Peau d'orange	14 (46.7)	6 (20.0)	4.800	1	0.028
Recognition of lump characteristics suggestive of malignancy	23 (76.7)	12 (40.0)	8.297	1	0.004
Referral-related decision-making: overall response distribution	—	—	—	—	0.001[a]
No action	0 (0.0)	1 (3.3)	—	—	—
Immediate medical referral	23 (76.7)	10 (33.3)	—	—	—
Delayed or non-urgent follow-up	7 (23.3)	14 (46.7)	—	—	—
Inappropriate action	0 (0.0)	5 (16.7)	—	—	—

Note. Data are presented as n (%). Warning-sign and lump-recognition values indicate correct responses; referral-related values indicate the distribution across four response categories. Pearson's chi-square tests without continuity correction were used for the seven binary recognition outcomes. [a]The overall referral-response distribution was compared using the two-sided Fisher–Freeman–Halton exact test because of small expected cell counts. Its p-value applies to the overall distribution, not specifically to the immediate-referral category. All p-values are unadjusted for multiple comparisons. Dashes indicate values that are not applicable. df = degrees of freedom.

Table-3: Post-intervention comparison of simulator-assessed breast lump detection performance between reproductive-age women and adolescent girls (n = 60).

Outcome	Reproductive-age women (n = 30), mean ± SD	Adolescent girls (n = 30), mean ± SD	Mean difference (95% CI)	t	df	P-value
Palpatory lump detection score (0–8)	3.20 ± 2.55	2.73 ± 2.57	0.47 (−0.86 to 1.79)	0.705	58	0.483

Note. Scores represent the number of correctly detected nodules among eight embedded resin nodules (5–20 mm) in a silicone breast phantom. The mean difference was calculated as the mean score for reproductive-age women minus that for adolescent girls. Between-group performance was compared using an independent-samples t-test. SD = standard deviation; CI = confidence interval; df = degrees of freedom.

4- DISCUSSION

This study identified a domain-specific pattern in breast health competencies following a standardized educational session among reproductive-age women and adolescent girls. Reproductive-age women more frequently recognized several visual warning signs, identified lump characteristics suggestive of malignancy, and selected immediate medical referral in a hypothetical clinical scenario. However, their numerically higher simulator-assessed nodule detection score was not statistically significant. Participants detected, on average, 3.20 of eight embedded nodules in the adult group and 2.73 in the adolescent group. Thus, the adult group's advantage in several recognition and referral-related outcomes was not accompanied by a clearly demonstrated advantage in tactile detection. These post-intervention comparisons identify residual educational needs but do not establish improvement from baseline or the effectiveness of the educational intervention.

4-1. Recognition of Warning Signs and Referral-Related Decision-Making

Adolescent girls demonstrated lower recognition of nipple discharge, breast erythema, sudden unilateral breast enlargement, and peau d'orange. However, between-group differences in nipple retraction and dilated superficial veins were not statistically significant. This pattern suggests that educational needs vary across individual symptoms and that breast health knowledge should not be treated as a single, uniformly developed competency.

These findings are consistent with the broader educational concerns identified by Malfatto and Calaf in their systematic review of breast cancer knowledge among school-level students. Their review identified a limited evidence base and highlighted variation in educational approaches and assessment methods. The present study complements this literature by considering symptom recognition alongside referral-related responses and an observed tactile detection task rather than relying exclusively on questionnaire-based knowledge assessment (11).

The adult group's higher recognition rates may reflect differences in reproductive experience, healthcare contact, or previous exposure to breast health information. Nevertheless, these explanations remain hypotheses. The groups also differed in marital status, schooling, breastfeeding

history, and recruitment setting, and the reported analyses did not isolate the independent contributions of these characteristics. Moreover, without pre-intervention assessment, it is not possible to determine whether the observed differences preceded instruction or reflected different responses to the educational session. The findings should therefore be interpreted as differences between the sampled groups rather than an independent effect of age or differential learning effectiveness.

Referral-related responses revealed an additional educational need. Immediate medical referral was selected by 76.7% of reproductive-age women but only 33.3% of adolescent girls. The significant difference in the overall response distribution indicates that the groups differed in their responses to the scenario, although the overall test does not provide a separate significance test for the immediate-referral category. Educational content should therefore connect recognition of concerning changes with clear guidance on obtaining professional assessment. However, hypothetical responses represent stated decisions and cannot establish actual healthcare attendance or the time taken to seek care.

Al-Hosni et al. reported that a school-based educational intervention in Oman improved awareness of breast cancer symptoms, reduced several perceived barriers to seeking medical help, and improved anticipated help-seeking. Their findings support integrating symptom recognition with discussion of help-seeking barriers and appropriate clinical pathways. Nevertheless, anticipated help-seeking and hypothetical referral responses should remain distinct from observed behavior and measured diagnostic delay (16).

4-2. Simulator-Assessed Palpation Performance

The relatively low mean number of embedded nodules detected in both groups was a central finding. The estimated mean difference was 0.47 nodules, with a 95% confidence interval ranging from −0.86 to 1.79. This interval includes both no difference and differences favoring either group. Consequently, the results do not demonstrate a statistically significant adult advantage, but neither do they establish equivalence between the groups.

The coexistence of higher recognition rates and limited tactile detection suggests that these domains should be assessed separately. However, no individual-level analysis of the relationship between recognition and palpation scores was reported. The findings therefore cannot establish that knowledge is unrelated to tactile performance or that increasing knowledge would fail to improve practical skills.

The scores also require careful clinical interpretation. Although participants detected fewer than half of the embedded nodules on average, no validated proficiency threshold was provided. The findings therefore describe detection performance under the study's assessment conditions rather than a validated level of clinical competence. Locating an embedded nodule in a phantom also differs from identifying a lesion in human tissue or determining whether it is benign or malignant.

Because assessment followed supervised practice, the observed scores reflect performance after exposure to the educational materials and phantom. They should not be interpreted as participants' unaided initial abilities. Conversely, without a pre-intervention measurement, the extent of any improvement cannot be determined.

External evidence supports further investigation of simulation-based learning. In a randomized controlled trial involving

Afghan refugee women, Kuru Alici et al. reported improvements in BSE skills and awareness-related outcomes following simulation-based education. This provides a rationale for evaluating supervised practice and feedback, but it does not establish the effectiveness of the simulator used in the present study (17).

4-3. Educational Approaches: Integrating Information, Practice, and Feedback

The present findings do not justify concluding that conventional or digital teaching methods are ineffective. Ogunmodede et al. reported improvements in BSE knowledge and observed practice scores following both lecture-based and podcast-based education among adolescent girls, with larger gains in the podcast group. Their findings indicate that different instructional formats can support learning and that educational value should be judged against clearly defined outcomes (6).

Evidence from Iran provides an additional comparison. Kucheki et al. evaluated a self-efficacy-based virtual educational intervention and reported improvements in observed BSE skills and self-efficacy relative to the control group, although the between-group difference in knowledge was not significant. These findings illustrate that knowledge, confidence, and observed performance may respond differently to the same educational program. They also support measuring practical performance directly rather than using knowledge scores as a substitute for skill assessment (20).

Broader evidence supports the potential educational benefits of structured interventions while emphasizing uncertainty. Mahar et al., in a systematic review and meta-analysis, reported higher odds of BSE practice following educational interventions. However, substantial heterogeneity indicated considerable variation across studies. Furthermore, increased examination practice is not equivalent to improved nodule detection, diagnostic accuracy, or reduced breast cancer mortality (21).

Taken together, these studies support evaluating complementary educational components rather than assuming that one delivery format is universally superior. Visual materials may support symptom recognition, case-based discussion may clarify help-seeking decisions, and supervised phantom practice may provide opportunities to assess and refine tactile detection. Whether this combination produces greater or more durable benefits than alternative instruction requires comparative investigation.

4-4. Connecting Education With Accessible Clinical Services

Improved awareness is only one component of an effective early diagnosis pathway. Okyere et al., in a systematic review of African intervention studies, reported improvements in breast cancer literacy and highlighted the importance of connecting education with access to services. The review also identified limitations, including reliance on self-reported outcomes, limited long-term follow-up, and insufficient economic evaluation. These findings emphasize that educational improvements should not automatically be interpreted as sustained behavioral change or improved clinical outcomes (22).

This distinction is particularly relevant to the referral-related findings of the present study. Teaching participants to recognize concerning changes should be accompanied by practical information about where and how to obtain assessment. Educational programs alone, however, cannot resolve financial, organizational, or geographical barriers to care.

Breast awareness should also be distinguished from population screening

and self-diagnosis. WHO describes early diagnosis as involving symptom awareness, timely clinical evaluation, and access to appropriate diagnostic and treatment services. Accordingly, phantom-based education should be framed as an educational activity rather than a substitute for professional assessment or an established population-screening strategy (2).

4-5. Clinical and Practical Implications

The findings suggest several priorities for educational practice and future program development.

First, adolescent-focused education should connect symptom information with practical guidance on obtaining help. The relatively low proportion selecting immediate medical referral after instruction suggests that the content, delivery, or comprehension of referral-related messages warrants further evaluation. Communication should emphasize timely professional assessment without implying that every breast change represents cancer or requires immediate surgical consultation. WHO notes that most breast lumps are not cancer but recommends medical assessment of abnormal lumps (2).

Second, practical assessment should complement knowledge assessment in both age groups. Higher recognition scores among reproductive-age women should not be assumed to indicate greater tactile detection ability. A phantom-based task may identify learning needs not captured by questionnaires, although its measurement properties and relationship to real-world outcomes require further evaluation.

Third, future educational programs should compare the contributions of visual materials, digital instruction, case-based discussion, supervised palpation, and feedback. Existing evidence indicates that several approaches can improve educational outcomes, but it does not establish which combination is most effective for adolescents or for the specific detection task used here (6, 17, 20).

Finally, implementation should be evaluated alongside effectiveness. Acceptability, educator training, instructional time, material costs, and access to subsequent clinical assessment are important considerations before recommending wider adoption. Recent review evidence identifies sustainability and economic evaluation as unresolved issues in breast health education (22).

4-6. Strengths and Limitations

Strengths include assessment of complementary recognition, referral-related, and tactile detection outcomes, an observed practical task rather than reliance solely on self-report, and standardized instruction across groups.

Limitations include the post-intervention-only design without a control group, which prevents conclusions about learning gains or intervention effectiveness. The small sample limited precision, and nonsignificant findings do not establish equivalence. Convenience recruitment from different settings and unadjusted demographic differences also limit attribution of group differences to age and generalizability beyond urban Kerman.

Phantom performance may not reflect examination of human breast tissue, and using the same model for practice and assessment may introduce familiarity. No validated proficiency threshold or long-term follow-up was available. Hypothetical referral responses do not establish actual help-seeking, and unadjusted multiple comparisons warrant cautious interpretation. Larger multicenter controlled studies with baseline assessment and follow-up should evaluate retention, transfer of skills, implementation feasibility, and real-world outcomes.

5- CONCLUSION

Following standardized education, reproductive-age women demonstrated higher recognition of several breast cancer warning signs and more appropriate referral-related responses than adolescent girls. However, the between-group difference in simulator-assessed nodule detection was not statistically significant, and both groups detected fewer than half of the embedded nodules on average. These findings identify residual educational needs across recognition, referral-related decision-making, and tactile detection but do not establish improvement from baseline or simulator effectiveness. Controlled studies incorporating pre-intervention assessment and longer-term follow-up are needed to evaluate learning gains, skill retention, implementation feasibility, and real-world help-seeking.

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7- AUTHORS' CONTRIBUTIONS

Study conception and design: AH and HB. Data analysis and initial manuscript drafting: MG, SN and MM. Critical revision of the manuscript: MG, and HB. Supervision of the research: AH and HB. Final approval of the version to be published: AH, MG, SN, MM, and HB.

8- CONFLICT OF INTEREST: None.

9- REFERENCES

1. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024 May-Jun;74(3):229-263. doi: 10.3322/caac.21834.

2. World Health Organization. *Breast cancer* [fact sheet]. Geneva: World Health Organization; 2026. Available from: https://www.who.int/news-room/fact-sheets/detail/breast-cancer.

3. Arnold M, Morgan E, Rumgay H, Mafra A, Singh D, Laversanne M, et al. Current and future burden of breast cancer: Global statistics for 2020 and 2040. Breast. 2022 Dec;66:15-23. doi: 10.1016/j.breast.2022.08.010. Epub 2022 Sep 2. PMID: 36084384; PMCID: PMC9465273.

4. World Health Organization. *Global breast cancer initiative implementation framework:* Assessing, strengthening and scaling-up of services for the early detection and management of breast cancer. Geneva: World Health Organization; 2023.

5. Ekim A, Subaşı DÖ, Ocakçı AF. Effect of breast cancer awareness education in adolescent girls: A quasi-experimental study. Journal of Education and Research in Nursing. 2024;21(2):137.

6. Ogunmodede EO, Ajala DE, Aluko JO, Anokwuru RA, Awotunde TA, Olajide AO, et al. Promoting breast health among female adolescents: a comparative analysis of the effects of two didactic tools on knowledge and practice regarding breast self-examination in Southwest Nigeria. BMC Cancer. 2024 Sep 27;24(1):1183. doi: 10.1186/s12885-024-12949-5. PMID: 39334017; PMCID: PMC11438366.

7. World Health Organization Regional Office for Africa. Evaluation and workup for suspected breast cancer using a primary health care approach. Geneva: World Health Organization; 2026. Available from: https://www.afro.who.int/publications/evaluation-and-workup-suspected-breast-cancer-using-primary-health-care-approach.

8. World Health Organization. Early detection of breast cancer. Cairo: World Health Organization Regional Office for the Eastern Mediterranean. Available from:

https://applications.emro.who.int/dsaf/dsa696.pdf.

9. World Health Organization. National cancer screening and early diagnosis guidelines. Geneva: World Health Organization; 2024. Available from: https://www.afro.who.int/countries/kenya/publication/national-cancer-screening-and-early-diagnosis-guidelines-second-edition-2024.

10. Mohebi Z, Heidari Sarvestani M, Moradi Z, Naghizadeh MM. Female high school students' knowledge and attitude toward breast cancer. BMC Womens Health. 2023 Jan 30;23(1):41. doi: 10.1186/s12905-023-02155-z. PMID: 36717852; PMCID: PMC9887865.

11. Malfatto CU, Calaf GM. A Systematic Review of Breast Cancer Knowledge Among School-Level Students Worldwide. J Cancer Educ. 2026 Mar;41(1):9-17. doi: 10.1007/s13187-025-02602-5. Epub 2025 Mar 19.

12. Ibitoye OF, Thupayegale-Tshwenegae G. The Impact of Education on Knowledge Attitude and Practice of Breast Self-Examination Among Adolescents Girls at the Fiwasaye Girls Grammar School Akure, Nigeria. J Cancer Educ. 2021 Feb;36(1):39-46. doi: 10.1007/s13187-019-01595-2. PMID: 31377988.

13. Milaat WA. Knowledge of secondary-school female students on breast cancer and breast self-examination in Jeddah, Saudi Arabia. East Mediterr Health J. 2000 Mar-May;6(2-3):338-44. PMID: 11556021.

14. Ifediora CO, Azuike EC. Tackling breast cancer in developing countries: insights from the knowledge, attitudes and practices on breast cancer and its prevention among Nigerian teenagers in secondary schools. J Prev Med Hyg. 2018 Dec 15;59(4):E282-E300. doi: 10.15167/2421-4248/jpmh2018.59.4.964.

15. Karayurt O, Ozmen D, Cetinkaya AC. Awareness of breast cancer risk factors and practice of breast self examination among high school students in Turkey. BMC Public Health. 2008 Oct 17;8:359. doi: 10.1186/1471-2458-8-359.

16. Al-Hosni K, Chan MF, Al-Azri M. Effectiveness of an Educational Program on Awareness of Breast Cancer Risk Factors, Symptoms, and Barriers to Seeking Medical Help among Adolescent Omani School Students-An Interventional Study. Curr Oncol. 2023 Apr 10;30(4):4126-4138. doi: 10.3390/curroncol30040314. PMID: 37185427; PMCID: PMC10137335.

17. Kuru Alici N, Arikan Dönmez A, Aktaş O, Zeytun Z. The effect of simulation-based breast health education on breast cancer awareness and breast self-examination skills of Afghan refugee women: a randomized controlled trial. BMC Public Health. 2025 Jun 2;25(1):2048. doi: 10.1186/s12889-025-23313-y. PMID: 40457306; PMCID: PMC12128285.

18. Özdemir A, Ünal E. The effect of breast self-examination training on nursing students by using hybrid-based simulation on knowledge, skills, and ability to correctly evaluate pathological findings: Randomized Controlled Study. Nurse Educ Pract. 2023 Jan;66:103530. doi: 10.1016/j.nepr.2022.103530. Epub 2022 Nov 29. PMID: 36462274.

19. World Health Organization. *Adolescent health* [fact sheet]. Geneva: World Health Organization. Available from: https://www.who.int/health-topics/adolescent-health#tab=tab_1.

20. Kucheki M, Nazari M, Arshadinejad R, Karimi M. The effect of a virtual educational intervention based on self-efficacy theory on women's skills of breast self- examination. BMC Womens Health. 2024 Nov 25;24(1):625. doi: 10.1186/s12905-024-03471-8.

21. Mahar B, Osman MB, Fauzi FA, Aliyu S. The impact of educational interventions on breast self-examination practice, knowledge, and beliefs among women: A systematic review and meta-analysis. J Public Health Res. 2026 Feb 24;15(1):22799036261423725. doi: 10.1177/22799036261423725.

22. Okyere J, Simkhada B, Simkhada P. A systematic review of the effectiveness of health education interventions on breast cancer literacy, screening uptake, and health beliefs in Africa. Discover public health. 2026 Dec 1;23(1):1476. Epub 2026 Sept 15. doi: 10.1186/s12982-026-02858-2.