Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

From Knowledge to Practice: Breast Cancer Awareness and Self-Examination in Two Cohorts of Health Science Students

Saima Habeeb
Government Medical College Anantnag
Chandrakala Sankarapandian
Princess Nourah bint Abdulrahman University
Jalal Alharbi
University of Hafr Al-Batin
Majed Alamri
M.alamri@uhb.edu.sa

University of Hafr Al-Batin

Research Article

Keywords: Cancer of breast, Awareness, Risk factors, BSE, Educational intervention, Paramedical education, Comparative study

Posted Date: August 11th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10306429/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Breast cancer represents a serious threat to global health due to its high incidence and marked disparities in morbidity and mortality, largely driven by inequities in access to early detection and comprehensive care. In addressing this complex public health issue, healthcare trainees occupy an indispensable role. Comprehensive knowledge of breast cancer enables them to serve as critical frontline advocates in health promotion and primary prevention.

Methods

To guide future academic endeavor, this study aims to compare knowledge, attitude, and practice (KAP) regarding breast cancer and self-examination practices between undergraduate nursing and paramedical students and to evaluate the effect of a structured educational intervention on both groups. This study was conducted with 256 students: Group A (nursing students, n = 128) and Group B (paramedical students, n = 128). Both groups completed a KAP questionnaire, received an educational intervention consisting of a lecture and a hands-on breast self-examination (BSE) workshop using anatomical models, and completed a follow-up questionnaire four weeks later.

Results

Descriptive and inferential statistical analysis revealed that the nursing students demonstrated significantly higher knowledge scores ($18.4 \pm 3.2 \, vs. \, 14.1 \pm 4.1, \, p < 0.001, \, d = 1.14$) and more positive attitudes ($28.5 \pm 4.3 \, vs. \, 24.8 \pm 5.1, \, p < 0.001, \, d = 0.77$). However, after the intervention, both groups showed significant improvement in all areas ($p < 0.001$), whereas specific knowledge gaps persisted among paramedical students regarding risk factors (recognition of genetic predisposition: 45% vs. 82% post-intervention) and screening guidelines.

Conclusions

The proposed intervention model offers a practical and effective strategy that could be applied across health care institutions, particularly among medical professionals, regardless of their field, to develop the confidence, commitment, and skills needed to effectively promote early detection of breast cancers in their communities. This study provides a clear road map for the curriculum reforms and implementation of effective educational intervention.

1. Introduction

Breast cancer is a major public health problem both globally and in India, with an increasing number of cases among females, and it is the primary cause of death within this population group. The number of cases among females is rising, with an extra 2.3 million cases predicted by GLOBOCAN (2022) [1]. Currently, 685,000 women worldwide lose their lives due to breast cancer each year, with one in 12 women suffering from the disease. With an estimated 178,000 new cases and 90,000 deaths annually, breast cancer has emerged as the most prevalent disease in India [2]. More precisely, it has become the most significant oncologic burden among women and is the leading cause of cancer-related deaths among Indian women, responsible for a high proportion of fatalities due to late-stage presentation. In contrast to Western populations, it is becoming more common in younger age groups [2, 3]. Improving survival outcomes still depends on early detection, especially in resource-constrained environments where sophisticated diagnostic infrastructure is not always available [4].

Breast cancer is a complex and multifaceted illness associated with both hereditary and random variables. It is pertinent to mention that the hereditary genetic mutation is linked to less than 10% of breast cancers, particularly those involving mutations in the BRCA1 or BRCA2 genes. However, environmental factors, primarily reproductive factors, and lifestyle factors (e.g., obesity and alcohol consumption) are more frequently linked to breast cancer than hormonal factors [5, 6]. Besides, breast cancer is also linked to individual health history, age, gender, race, and breast density, particularly reproductive history. These factors all contribute to the complexity of breast cancer risk [7]. Furthermore, there are several warning signs of breast cancer, such as the development of a lump or tumor, skin changes such as redness, puckering, or dimpling, unexplained discomfort, and changes to the size and shape of the breast. Early detection is essential for effective therapy. To create effective prevention, both individuals and healthcare professionals must understand these complex risk factors and symptoms to develop effective prevention programmes and raise awareness of the disease, which remains highly prevalent despite the availability of treatment [8, 9].

In low and middle-income countries such as India, breast self-examination (BSE) is still useful even if it is no longer advised as a standalone screening technique in high-income nations. It has been reported that 50–70% of breast cancer cases in India are diagnosed at advanced stages; as such, BSE is an essential tool for raising breast awareness, increasing proactive health-seeking behavior, and aiding earlier presentation [10]. It has been demonstrated that BSE-based educational interventions and initiatives are successful in raising awareness and encouraging practice among diverse populations. In places like India, where access to conventional mammography and medical examinations is restricted, routine breast self-examinations are crucial for early diagnosis of breast cancer [11]. However, there are differences in self-examination techniques and general population comprehension. Even though the disease is quite common, studies conducted in countries like Egypt and the United Arab Emirates have shown how important it is to improve community outreach and education [12, 13]. However, following an intervention program, a study of teenage Malaysian females showed a notable change in breast self-examination (BSE) practices. Similarly, Korkut's survey of 668 women in Western Turkey found that higher education levels were associated with increased frequencies of BSE [14]. Even among medical

professionals in Morocco, Nigeria, and Rwanda, there are clear differences in knowledge and practices, with physicians and nurses having somewhat higher awareness [15, 16].

Healthcare trainees—future nurses, laboratory technologists, radiographers, and other allied health professionals play a pivotal role in cancer control efforts, strengthening healthcare systems, reducing diagnostic delays, alleviating patient anxiety, and improving survival and quality of life metrics globally. Thus, the competency of frontline healthcare workers and community educators in breast cancer knowledge directly affects public health outcomes. While both nursing and paramedical curricula are within the health sciences domain, they differ fundamentally in their pedagogical focus. It is often observed that nursing education traditionally emphasizes holistic patient assessment, health promotion, and direct patient communication, with oncology nursing modules integrated into the curriculum [17]. In contrast, the paramedical education (comprising fields such as medical laboratory technology, radiography, and other allied health courses) is intended to prioritize diagnostic, technical, and therapeutic skills, placing relatively less emphasis on preventive oncology and patient counselling. This curricular divergence potentially created disparities in foundational cancer awareness that had not previously been systematically explored in the Indian context.

This study was conducted to address three major issues: (i) the lack of comparative data on knowledge, attitude, and practice (KAP) regarding breast cancer among nursing and paramedical students in India; (ii) the need to evaluate the efficacy of a standardized educational intervention across different health disciplines; and (iii) the need to inform the development of a comprehensive cancer education curriculum. The primary objective of this study is to provide evidence-based recommendations for enhancing the training of healthcare professionals and fostering inter-professional collaboration in cancer prevention.

2. Materials and Methods

This section presents a detailed description of the research study design, study setting, study population, sample size, sampling technique, educational intervention, and evaluation tools employed in the study.

2.1. Study Design

This study was conducted in accordance with the Declaration of Helsinki. A quasi-experimental, two-group, pre-test/post-test comparative study was conducted between July and October 2025. This study received approval from the Institutional Ethics Committee of the Government Medical College, Anantnag, IEC code: IEC-GMCA/Proposal/2025/65. Written informed consent was obtained from all participants after the purpose, procedures, risks, and benefits of the study were explained to them. Confidentiality was maintained by the anonymity of the data.

2.2. Study Setting and Population

The study was conducted at the Government Nursing College and Paramedical Sciences, Anantnag. The college offers Bachelor of Science degrees in Nursing, Medical Laboratory Technology (BSc MLT), and Radiology (BSc RD). The target population comprised female undergraduate students enrolled in these programmes.

2.3. Sampling and Sample Size

G*Power software, version 3.1.9.7, was used to determine the sample size. To detect a moderate effect size (Cohen's d = 0.5) in knowledge score differences between groups with 80% power and a 5% alpha error (two-tailed), a minimum of 128 participants per group was required. Anticipating a potential attrition rate of approximately 10%, the initial recruitment target was set at 142 individuals per group.

During the course of the study, 14 participants from each group were lost to follow-up or did not complete both assessments, resulting in an actual attrition rate of 9.8%. Consequently, the final sample included in the analysis consisted of exactly 128 students per group (N = 256), successfully meeting the predetermined statistical power requirements. The sampling method utilized was stratified convenience sampling. The target population was divided into two main strata: paramedical (B.Sc. MLT and B.Sc. RD) and nursing (B.Sc. Nursing). Students from each stratum in their first, second, and third academic years were invited to participate until the necessary sample size was fulfilled.

2.4. Inclusion and Exclusion Criteria

a) Inclusion criteria:

1. Female students enrolled in BSc Nursing or BSc Paramedical programmes.
2. Aged 18–25 years.
3. Willing to take part and provided informed consent.

b) **Exclusion criteria**:

1. A personal history of breast cancer or any other type of malignancy.
2. Having previously participated in a certified BSE training workshop outside the standard curriculum;
3. Being a student in the final stage of their internship or examinations.

2.5. Study Instrument and Validation

A structured, self-administered questionnaire was developed through an extensive review of literature and existing validated tools [18, 19].

The instrument underwent a rigorous validation process:

Content validity: This was assessed by a panel of five experts (two surgical oncologists, one community medicine specialist, one nursing educator, and one medical educationist). The Content Validity Index (CVI) for the overall scale was 0.92.

Face validity: This was evaluated through cognitive interviews with ten students (five from each discipline).

Pilot testing: A pilot study was conducted with 30 students (15 from each group), who were not included in the main study. The internal consistency was excellent (Cronbach's alpha = 0.87 for the knowledge section, 0.82 for the attitude section and 0.79 for the practice section). Reliability: Reliability was checked by the test-retest method. The questionnaire was administered to 20 students with a two-week interval, showing a strong correlation ($r = 0.89,\ p < 0.001$).

The structured, self-administered questionnaire comprised of four sections.

Section A: It consists of socio-demographic and academic characteristics (7 items): age, year of study, course, oncology module completed, prior BSE training, family history of cancer, and primary source of information.

Section B: It includes a knowledge assessment (25 items): epidemiology (3 items), risk factors (6 items), signs and symptoms (5 items), screening (6 items), and BSE technique (5 items). Response format: True/False/Don't Know, with multiple-choice questions. Scoring: 1 point for each correct answer and 0 points for an incorrect answer or "don't know."

Total score range: 0–25 (See Table 1).

Section C: Attitude Assessment (10 items): This section measures perceptions regarding breast cancer severity, susceptibility, the benefits of early detection, confidence in performing/teaching BSE, and perceived professional responsibility. A 5-point Likert scale was used (1 = Strongly Disagree to 5 = Strongly Agree). Total score range: 10–50, with higher scores indicating a more positive attitude.

Section D: Practice Assessment (16-point scale): This section assessed prior BSE practice, frequency, technique accuracy (using an 8-step checklist), barriers to practice, and experience of teaching BSE to others. Scoring for practice frequency: Never = 0, Irregularly = 1, Monthly = 2, Weekly = 3. Technique checklist: 1 point per correctly identified step (range 0–8), taught others (0–5).

Table 1
Survey tool structure for assessing breast cancer knowledge

Concept	No of questions	Answer format	Scoring method
Knowledge Assessment	25 Questions	True/False/Don't know	
Epidemiology	3 questions	True/False/Don't know	1 point for Yes, 0 for No or Don't know
Risk Factors	6 questions	True/False /Don't know	1 point for Yes, 0 for No or Don't know
Signs & Symptoms	5 questions	True/False /Don't know	1 point for Yes, 0 for No or Don't know
Screening	6 questions	True/False /Don't know	1 point for Yes, 0 for No or Don't know
BSE Technique	5 questions	True/False /Don't know	1 point for Yes, 0 for No or Don't know

2.6. Educational Intervention

A standardized 80-minute educational intervention was developed by a multidisciplinary team and delivered in the same way to both groups by the same facilitators (the principal investigator and a certified nurse educator). The following components of educational intervention were carried out:

1. Interactive Lecture (45 minutes): A 45-minute interactive PowerPoint presentation was conducted that covered global and national epidemiology of breast cancer; modifiable and non-modifiable risk factors with a focus on the Indian context; early signs and symptoms; diagnostic modalities (clinical breast examination, mammography, ultrasound, and biopsy); screening guidelines according to the Indian Council of Medical Research (ICMR) and the National Comprehensive Cancer Network (NCCN); the rationale for BSE as an awareness tool in settings with limited resources.
2. Hands-on Skills Workshop (30 minutes): High-fidelity silicone breast models with implanted artificial lumps were used to demonstrate the proper BSE approach step by step. Participants practiced under supervision and received individual feedback. The technique focussed on timing (5–7 days after menstruation), systematic palpation patterns (vertical strip, circular or wedge), proper finger use (pads of the three middle fingers); and inspection for visual changes.
3. Q&A and Resource Distribution (5 minutes): Participants received an illustrated, bilingual (English/Urdu) pamphlet summarizing key information and BSE steps, along with contact information for local screening facilities.

2.7. Data Collection

Data was collected over a period of 4 months from July to October 2025. Written informed consent was obtained from both groups (nursing & paramedical students) after the confidentiality of the data was

explained to them. We have followed the following procedure:

(a) **First Phase (Pre-intervention Phase)**: The baseline information was gathered from respondents using a structured questionnaire, which assessed socio-demographic data alongside prior knowledge, attitude, and practices regarding breast cancer and BSE.

(b) **Second Phase (Intervention Phase)**: Following the pre-test, participants were given a 15-min break and reorganized into smaller cohorts of ten to fifteen individuals to ensure an optimal instructor-to-student ratio. The educational intervention comprising lectures, interactive discussions, brainstorming sessions, PowerPoint presentations, and step-by-step hands on BSE demonstration which was delivered to these subgroups in designated skill laboratories. The pre-test and intervention sessions were completed on the same day. To ensure comprehension of the instructional materials, one or two respondents from each group were asked to share what they had learned throughout the session.

(c) **Third Phase (Post-test Phase)**: Four weeks following the interventional educational session, respondents were re-evaluated using the identical questionnaire to assess changes and retention in their knowledge of breast cancer and BSE-related behaviours. Each respondent was tracked using a unique, anonymized identification number.

2.8. Statistical Analysis

The data was analysed using IBM SPSS Statistics version 26.0. Descriptive statistics were presented as the mean ± standard deviation (SD) for normally distributed continuous variables, the median (interquartile range) for non-normal data and frequencies (percentages) for categorical variables. For the inferential statistics, we carried out the following procedure:

1. Between-group Comparisons at Baseline: Independent samples for normally distributed continuous variables were tested by t-test whereas the chi-square test (or Fisher's exact test) was employed for categorical variables.
2. Within-group Changes (Pre-post): Paired samples were analyzed by employing the t-test.
3. Comparison of Post-intervention Outcomes: Analysis of covariance (ANCOVA) was used to compare post-test scores within the groups as the dependent variable, groups as the fixed factor, and the pre-test score as the covariate. The assumptions of homogeneity of regression slopes and normality of residuals were verified.
4. Effect Sizes: Cohen's d for t-tests (0.2 = small, 0.5 = medium, 0.8 = large), partial eta-squared (η²) for ANCOVA (0.01 = small, 0.06 = medium, 0.14 = large), and Cramer's V for chi-square tests.
5. Subgroup Analysis: A two-way mixed ANOVA was used to examine the interaction between time (pre/post) and groups (nursing/paramedical). Statistical significance was set at $p < 0.05$ (two-tailed).

3. Results of the Study

Initially, we analyzed the distribution of subjects of all the participants according to their socio-demographic and academic characteristics, followed by baseline knowledge, attitude, and practice comparison. Then, we examined the changes in knowledge, attitude, and practice scores within groups. Finally, a comparison of post-intervention outcomes among groups and persistent knowledge gaps is briefly studied.

3.1. Socio-demographic and Academic Characteristics

All participants (Nursing = 128 & Paramedical = 128, $n = 256$) completed both assessments. It is quite evident from Table 2 thatssignificant differences were found in terms of academic exposure, though: a significantly higher percentage of nursing students reported a family history of cancer ($18.0\% \; vs. \; 9.4\%, \; p = 0.04, \; d = 0.14$) and had completed an oncology module as part of their curriculum (91.4% vs. 65.6%, $p < 0.001, \; d = 0.29$). For all categories, social media and the internet were the main sources of prior information on breast cancer (64.1%), followed by the academic curriculum.

Table 2

Distribution of subjects according to their socio-demographic and academic characteristics ($N = 256$).

Characteristics	Category	Nursing n = 128	Paramedical n = 128	χ²/t-value	$\varvec{p}$ -value	$\varvec{d}$ -value
Age in years	Mean + SD	20.1 + 1.4	20.5 + 1.6	t = 1.89	0.06	d = 0.27
Year of study	Ist year	45 (35.2)	38 (29.7)	χ²=2.98	0.22	d = 0.11
	2nd year	52 (40.6)	58 (45.3)			
	3rd year	31 (24.2)	32 (25.0)			
Course	Bsc Nursing	128(100)	0 (0)			
	Bsc MLT	0 (0)	68 (53.1)			
	Bsc RD	0 (0)	60 (46.9)			
Oncology module completed	Yes	117 (91.4)	84 (65.6)	χ²=26.4	0.001	d = 0.29
Family history of cancer	Yes	23 (18.0)	12(9.4)	χ²=4.2	0.04	d = 0.14
Prior BSE Training	Yes	41 (32)	29(22.7)	χ²=2.9	0.09	d = 0.11
Primary information source	Academic curriculum	38 (29.7)	25 (19.5)	χ²=9.7	0.08	d = 0.20
	Internet/ Social media	82 (64.1)	78 (60.9)			
	Healthcare Professional	8 (6.2)	25 (19.5)			

3.2. Comparison of Baseline Knowledge, Attitude and Practice (KAP)

From Table 3, we infer that nursing students had higher baseline knowledge scores than those of paramedical students ($18.4 \pm 3.2 \, vs. \, 14.1 \pm 4.1$, $p < 0.001$, $d = 1.14$, large effect size). The difference was apparent due their understanding of risk factors (Nursing: 4.8 ± 1.1 vs. Paramedical: 3.2 ± 1.4, $p < 0.001$) and screening guidelines (Nursing: 3.9 ± 1.0 vs. Paramedical: 2.8 ± 1.3, $p < 0.001$). Moreover, the nursing students had significantly higher attitude scores (28.5 ± 4.3 vs. 24.8 ± 5.1, $p < 0.001$, $d = 0.77$, medium-large effect size), especially

regarding their sense of professional responsibility to educate others (Nursing: 4.1 ± 0.9 vs. Paramedical: 3.5 ± 1.1, $p < 0.001$). However, the two groups do not show any significant differences in baseline practice scores (5.8 ± 3.1 vs. 5.2 ± 3.5, $p = 0.13$, $d = 0.18$). Both groups reported low levels of regular BSE practice (Nursing: 1.1 ± 0.9; Paramedical: 0.9 ± 0.8, $p = 0.07$).

Table 3
Baseline Knowledge, Attitude, and Practice comparison

Domain	Maximum Score	Nursing n = 128	Paramedical n = 128	Mean difference (95% CI)	\varvec$p$ -value	\varvec$d$ -value
Knowledge	**25**	**18.4 ± 3.2**	**14.1 ± 4.1**	**4.3 (3.4 to 5.2)**	**< 0.001**	**d = 1.14**
Epidemiology	3	2.1 ± 0.7	1.8 ± 0.8	0.3 (0.1 to 0.5)	0.002	0.40
Risk factors	6	4.8 ± 1.1	58 (45.3)3.2 ± 1.4	1.6 (1.3 to 1.9)	< 0.001	1.27
Signs and symptoms	5	4.2 ± 0.9	3.5 ± 1.2	0.7 (0.4 to 1.0)	< 0.001	0.67
Screening	6	3.9 ± 1.0	2.8 ± 1.3	1.1 (0.8 to 1.4)	< 0.001	0.94
BSE Technique	5	3.4 ± 1.2	2.8 ± 1.4	0.6(0.3 to 0.9) 3.9	< 0.001	0.46
Attitude	**50**	**28.5 ± 4.3**	**24.8 ± 5.1**	**3.7 (2.5 to 4.9)**	**< 0.001**	**0.77**
Perceived severity	10	8.2 ± 1.4	7.8 ± 1.7	0.4(-0.1 to 0.9)	0.14	0.26
Perceived susceptibility	10	5.4 ± 1.9	5.1 ± 2.1	0.3(-0.2 to 0.8)	0.23	0.15
Benefits of early detection	10	7.2 ± 1.8	6.3 ± 2.0	0.9 (0.4 to 1.4)	< 0.001	0.48
Barriers to BSE Practice	10	4.1 ± 1.9	3.8 ± 2.1	0.3(-0.2 to 0.8)	0.27	0.15
Confidence in BSE	5	3.4 ± 1.1	2.6 ± 1.2	0.8 (0.5 to 1.1)	< 0.001	0.69
Professional responsibility	5	4.1 ± 0.9	3.5 ± 1.1	0.6 (0.4 to 0.8)	< 0.001	0.60
Practice	**16**	**5.8 ± 3.1**	**5.2 ± 3.5**	**0.6(-0.2 to 1.4)**	**0.13**	**0.18**
Practice frequency	3	1.1 ± 0.9	0.9 ± 0.8	0.2 (0.0 to 0.4)	0.07	0.23
Technique score	8	3.2 ± 2.1	2.9 ± 2.3	0.3(-0.2 to 0.8)	0.27	0.14
Taught others	5	1.5 ± 1.4	1.4 ± 1.5	0.1(-0.2 to 0.4)	0.55	0.07

3.3. Changes within Groups after the Intervention

From pre-test to post-test, both groups showed statistically significant improvements in every KAP domain (all $p < 0.001$). Particularly, the nursing students' knowledge had increased from 18.4 to 22.7 (mean difference: 4.3 points, 95% CI: $3.8 - 4.8$, $t = 17.2$, $p < 0.001$, $d = 1.51$), while the paramedical students showed an even greater absolute improvement (14.1 to 19.6, mean difference: 5.5 points, 95% CI: $4.8 - 6.2$, $t = 15.8$, $p < 0.001$, $d = 1.34$). From Table 4, we observe that the attitude scores for both groups had significantly improved, although paramedical student's improvement was higher in comparison to nursing students (8.1 points compared to 5.7 points for nursing students). Furthermore, it is pertinent to mention that practice scores exponentially enhanced in both groups (10.5 ± 2.9 vs. 9.8 ± 3.2; within-group d = 1.52 and 1.31, respectively).

Table 4
Within-Group Changes in Knowledge, Attitude, and Practice Scores.

Group	Domain	Pre-test Mean ± SD	Post-test Mean ± SD	Mean difference (95% CI)	$\varvec{t}$ -value	$\varvec{p}$ -value	$\varvec{d}$ -value
Nursing	Knowledge	18.4 ± 3.2	22.7 ± 2.1	4.3 (3.8 to 4.8)	17.2	< 0.001	d = 1.51
	Attitude	28.5 ± 4.3	34.2 ± 3.8	5.7(4.9 to 6.5)	14.1	< 0.001	1.38
	Practice	5.8 ± 3.1	10.5 ± 2.9	4.7(4.1 to 5.3)	15.9	< 0.001	1.52
Paramedical	Knowledge	14.1 ± 4.1	19.6 ± 3.0	5.5(4.8 to 6.2)	15.8	< 0.001	1.34
	Attitude	24.8 ± 5.1	32.9 ± 4.5	8.1(7.1 to 9.1)	16.2	< 0.001	1.61
	Practice	5.2 ± 3.5	9.8 ± 3.2	4.6 (3.9 to 5.3)	13.5	< 0.001	1.31

3.4. Comparison of Post-intervention Outcomes with Groups (ANCOVA)

To compare post-intervention results within groups while accounting for baseline scores, ANCOVA was used. From Table 5, we infer that the nursing students had outperformed paramedical students in terms of knowledge after intervention (adjusted mean difference: 2.7 points; $F(1, 253) = 32.5$; $p < 0.001$; partial $\eta^2 = 0.114$; medium effect). But neither the attitude ($F(1, 253) = 1.8$, $p = 0.18$, $\eta^2 = 0.007$) nor the practice scores ($F(1, 253) = 0.9$, $p = 0.34$, $\eta^2 = 0.004$) had shown any significant differences within groups.

Table 5
ANCOVA Results Comparing Post-test Scores Adjusted for Baseline Scores.

Domain	Group	Adjusted post-test Mean	Unadjusted mean difference	$\varvec{F}$ -static (df)	$\varvec{p}$ -value	Partial $\varvec{\eta}^2$
Knowledge	Nursing	22.5 (0.2)	3.1	32.5 (1253)	< 0.001	0.114
	Paramedical	19.8(0.2)				
Attitude	Nursing	33.9(0.4)	1.3	1.8	0.18	0.007
	Paramedical	33.1(0.4)				
Practice	Nursing	10.3(0.3)	0.7	0.9	0.34	0.004
	Paramedical	10.0(0.3)				

Note: Covariates evaluated at: Knowledge pre-test = 16.25, Attitude pre-test = 26.65, Practice pre-test = 5.50

3.5. Two-way Mixed ANOVA: Time × Group Interaction

A two-way mixed ANOVA revealed that significant improvements over time differed by group for knowledge ($F(1,\ 254)\ =\ 8.7,\ p\ =\ 0.003$, partial $\eta^2\ =\ 0.033$) and attitude ($F(1,\ 254)\ =\ 12.4,\ p\ <\ 0.001,\ \eta^2\ =\ 0.047$), but not for practice ($F(1,\ 254)\ =\ 0.1,\ p\ =\ 0.75,\ \eta^2\ =\ 0.0004$). This indicates significant interaction effects were found for knowledge and attitude. Paramedical students showed the strongest gains in attitude, while nursing students had more pronounced and sustained knowledge improvement. No differential effect was observed for practice.

3.6. Item-level Analysis of Persistent Knowledge Gaps

According to a detailed item analysis (Table 6), there were significant differences between nursing and paramedical students on every item in the 25-knowledge assessment questionnaire. The questions about auxiliary tail inclusion in BSE (Item $24:\ 76.6\%$ vs 43.8%, χ^2=30.19, p < 0.001), appropriate screening frequency (Item 16: 79.7% vs $50.0\%,\ \chi^2\ =\ 25.76,\ p\ <\ 0.001$), and mammography starting age (Item 15: 89.1% vs $60.9\%,\ \chi^2\ =\ 28.41,\ p\ <\ 0.001$) showed the largest performance gaps, which were greater than 28% (> 28).

Table 6
Detailed item analysis of breast cancer knowledge of Nursing and Paramedical students.

Item	Question	Correct Answer	Nursing (n = 128)	Paramedical (n = 128)	Statistical result
Epidemiology	What is the most common cancer among women worldwide?	Breast cancer	121 (94.5)	108 (84.4%)	X^2=7.21 (0.007)
	At what age range does breast cancer incidence peak in Indian women?	40–50 years	89 (69.5%)	67 (52.3%)	χ^2=8.15 (0.004)
	What is the leading cause of cancer death in Indian women?	Breast cancer	95 (74.2%)	71 (55.5%)	χ^2=10.33 0.001
Risk factors	Which is the strongest non-modifiable risk factor for breast cancer?	Family history	115 (89.8%)	82 (64.1%)	χ^2=25.64 < 0.001
	BRCA gene mutation increases breast cancer risk?	5–10 times	78 (60.9%)	42 (32.8%)	χ^2=21.81 < 0.001
	Early menarche (first period) is considered a risk factor if it occurs before age.	12 years	92 (71.9%)	58 (45.3%)	χ^2=19.72 < 0.001
	Late menopause is considered a risk factor if it occurs after age.	55 years	84 (65.6%)	48 (37.5%)	χ^2=21.39 < 0.001
	First childbirth after age 30 increases breast cancer risk.	True	106 (82.8%)	68 (53.1%)	χ^2=27.94 < 0.001
	Obesity (BMI > 30) increases breast cancer risk.	True	118 (92.2%)	94 (73.4%)	χ^2=15.81 < 0.001
Signs and symptoms	What is the most common first sign of breast cancer?	Painless lump	122 (95.3%)	106 (82.8%)	χ^2=10.85 0.001
	Nipple retraction (inversion) can be a	True	116 (90.6%)	89 (69.5%)	χ^2=18.32 < 0.001

Item	Question	Correct Answer	Nursing (n = 128)	Paramedical (n = 128)	Statistical result
	sign of breast cancer:				
	Breast pain (mastalgia) is commonly present in early breast cancer:	False	85 (66.4%)	54 (42.2%)	χ^2=16.27 < 0.001
	orange peel appearance of breast skin indicates:	Advanced/locally advanced cancer	79 (61.7%)	42 (32.8%)	χ^2=22.47 < 0.001
	Bloody nipple discharge suggests:	Possible breast cancer	110 (85.9%)	78 (60.9%)	χ^2=21.86 < 0.001
Screening	At what age is screening mammography recommended to begin for average-risk women in India?	40 years	114 (89.1%)	78 (60.9%)	χ^2=28.41 < 0.001
	How frequently should screening mammography be done?	Annually	102 (79.7%)	64 (50.0%)	χ^2=25.76 < 0.001
	Clinical breast examination (CBE) is recommended from age:	20 years	89 (69.5%)	52 (40.6%)	χ^2=22.60 < 0.001
	Women with family history of breast cancer should begin screening earlier:	True	106 (82.8%)	72 (56.3%)	χ^2=22.17 < 0.001
	Breast self-examination (BSE) should be performed:	Monthly	120 (93.8%)	98 (76.6%)	χ^2=14.81 < 0.001
	Ultrasound is the primary screening tool for breast cancer:	False	76 (59.4%)	42 (32.8%)	χ^2=19.77 < 0.001
BSE Technique	The best time for BSE in	5–7 days after menses	120 (93.8%)	100 (78.1%)	χ^2=13.15 < 0.001

Item	Question	Correct Answer	Nursing (n = 128)	Paramedical (n = 128)	Statistical result
	menstruating women is: 5–7 days after menses:				
	The correct finger position for breast palpation during BSE is:	Pads of three middle fingers	112 (87.5%)	82 (64.1%)	χ^2=19.77 < 0.001
	The systematic pattern recommended for breast palpation is:	Vertical strip pattern	105 (82.0%)	68 (53.1%)	χ^2=24.82 < 0.001
	Which area should be included during BSE?	Axillary tail	98 (76.6%)	56 (43.8%)	χ^2=30.19 < 0.001
	What should be looked for during visual inspection before palpation?	Dimpling, puckering, nipple changes	116 (90.6%)	84 (65.6%)	χ^2=23.82 < 0.001

3.7. Item-level Analysis of Attitude Assessment

Table 7 presents the item-level analysis of attitude assessment across both groups. The analysis revealed that nursing students demonstrated significantly higher confidence in performing BSE (3.4 ± 1.1 vs 2.6 ± 1.2, $p< 0.001$), and a stronger sense of professional responsibility to teach others (4.2 ± 0.8 vs $3.6\ :\pm\ :1.0,\ :p<0.001$), while both groups showed similar perceptions of breast cancer severity and barriers to practice.

Table 7
Item Analysis of Attitude Assessment (50-Point scale, 10 items)

Item	Attitude Statement (5 Point Likert Scale)	Domain	Nursing Mean ± SD	Paramedical Mean ± SD	Statistical Result
1.	Breast cancer is a serious health problem for women in India:	Severity	4.2 ± 0.8	4.1 ± 0.9 0.1	0.305
2.	Breast cancer can affect women of any age, including young women	Susceptibility	4.0 ± 0.9	3.9 ± 1.0	0.380
3.	Early detection of breast cancer significantly improves survival chances	Benefits	4.5 ± 0.6	4.3 ± 0.7	0.014
4.	Breast self-examination (BSE) is an effective method for early detection	Benefits	4.3 ± 0.7	4.0 ± 0.8	0.001
5.	I feel confident in my ability to perform BSE correctly	Confidence	3.4 ± 1.1	2.6 ± 1.2	< 0.001
6.	I would know what to do if I found a lump during BSE	Confidence	3.2 ± 1.0	2.6 ± 1.1	< 0.001
7.	As a future health professional, teaching BSE to others is my responsibility	Professional	4.2 ± 0.8	3.6 ± 1.0	< 0.001
8.	I should educate my family members about breast cancer prevention professional	Professional	4.0 ± 0.9	3.4 ± 1.1	< 0.001
9.	Lack of knowledge is a major barrier to performing regular BSE	Barrier	3.8 ± 1.0	3.6 ± 1.1	0.123
10.	Fear of finding something abnormal prevents me from doing BSE regularly	Barriers	3.2 ± 1.1	3.1 ± 1.2	0.478

4. Discussion

This study compares the levels of breast cancer knowledge, attitude, and practice (KAP) among nursing and paramedical students before and after the intervention. The findings highlight common issues and gaps specific to each discipline that need to be addressed to strengthen the country's oncology workforce. The study also offers valuable insights into the educational readiness of these future frontline healthcare providers. The major findings of this investigation are briefly discussed below:

4.1. Baseline Differences in Breast Cancer Knowledge

As far as the knowledge of breast cancer is concerned, our study has revealed significant differences between nursing and paramedical students before intervention ($d = 1.14$) because oncology and health promotion courses are included in their curriculum, which often feature specific modules on cancer nursing, health assessment, and patient education. On the other hand, paramedical programmes neglect comprehensive cancer education, as they often break down information by system or method, while still being scientifically thorough. This difference in curriculum is evident since only 65.6% of paramedical students completed an oncology module, while 91.4% of nursing students did. In this study, we have observed that there is a knowledge gap regarding genetic risk factors and screening standards among paramedical students, which is concerning as they will work as laboratory technicians and radiographers for conducting genetic testing and performing mammograms, respectively. This disconnects between their technical role and their understanding of the context may hinder effective patient communication and the delivery of complete treatment.

4.2. Response to Educational Intervention

The intervention was highly effective for both groups, with large effect sizes ($d = 1.31 - 1.61$) that were on par with or higher than those found in related research [16, 17]. However, the differences in attitude scores were instructive, as the paramedical students had shown higher absolute gains in attitude scores (8.1 vs. 5.7 points) and knowledge (5.5 vs. 4.3 points) which reflects that they are a "high-potential" group with significant scope for improvement. The higher baseline scores obtained by the nursing students are supported by the “ceiling effect theory” whereas the better adjusted post-intervention knowledge ratings retained by the nursing students had been shown by ANCOVA, although the paramedical students demonstrated more progress in post-intervention knowledge. This persistent disparity even after the educational intervention implies that brief educational sessions are unable to fully compensate for the curricular inequalities, because the knowledge domain of nursing students could be an indication of stronger conceptual understanding, which has been cultivated through repeated reinforcement throughout their curriculum.

4.3. Equalization of Attitudes and Practice Intentions

After the intervention, the most noticeable findings in our study were the changes in attitude and practice scores among both groups. Particularly, the self-assurance, perceived accountability and responsibility, and BSE practice have shown similar levels of improvement, which are clinically significant, as attitudes and self-practices are powerful determinants of real health-promoting behaviors among healthcare workers. This equalization was much aided by the hands-on workshop component, which reduced fear and anxiety and increased the competence level of students independent of prior knowledge.

4.4. Persistent Specific Knowledge Gaps

From Table 6, we observe that the paramedical students still have significant knowledge gaps, especially regarding genetics and screening guidelines for diagnosis and treatment, which are consistent with

earlier studies [17]. These disparities could be addressed with specific curriculum updates by including the genetic counselling concepts in radiography programmes and ensuring that pathology and medical laboratory technology students understand the clinical significance of their findings.

4.5. Implications for Medical Education and Health Policy

On the basis of study findings, we have the following important implications:

1. Curriculum Standardization: Develop standardized cancer education modules for all healthcare students, especially in India, which should include essential skills in cancer prevention, early diagnosis and detection, communication, and referral pathways.
2. Skills-Based Training: Even with improved knowledge, the technical gaps show that students need frequent, supervised practice sessions instead of just one-time demonstrations. For breast self-examination, Objective Structured Clinical Examinations (OSCEs) could provide necessary reinforcement.
3. Inter-professional Education (IPE): The unique strengths of each group suggest opportunities for collaborative learning. For example, nursing students should guide paramedical peers in patient communication, while paramedical students should help nursing students to understand diagnostic technologies. This approach truly reflects clinical teamwork.
4. Resource Allocation: In countries like India, investment in the education of paramedical students could significantly enhance the breast cancer awareness workforce.
5. Longitudinal Training: The success of the intervention supports adding similar workshops to the regular health science curriculum, with periodic reinforcement to maintain knowledge and skills.

4.6. Strengths and Limitations

The strengths of this study include its strong comparative design, an adequate sample size with zero attrition, and the use of standardized intervention and validated instruments supported by comprehensive statistical analysis, including effect sizes and ANCOVA. However the study has also the following limitations:

1. Future research should incorporate an objective assessment of skills because self-reported practice measures are prone to social desirability bias.
2. It was not possible to evaluate long-term retention during the four-week follow-up period as such, it is necessary to conduct longitudinal research with follow-ups of six to twelve months.
3. The paramedical group comprised of two specializations (MLT and radiology), may have had internal variations that were not investigated.
4. The single institution design limits generalizability to other settings and populations.

4.7. Future Research Directions and Recommendations

The future research work should focus on the following:

1. Examine the retention of long-term knowledge and skillthrogh longitudinal studies with 6–12-month follow-ups.
2. Examine actual behavioral outcomes (e.g., teaching BSE to patients/families) using objective assessment methods.
3. Develop and evaluate discipline-specific instructional modules.
4. Explore challenges and barriers to implement breast cancer education in health science curriculum.
5. Evaluate the cost effectiveness of intervention.
6. Develop structured clinical rotations in oncology departments and screening clinics for all healthcare trainees.
7. Conduct multi-center studies to enhance generalizability of findings.

5. Conclusion

This study has demonstrated that the knowledge, attitudes, and self-reported practices regarding breast cancer have significantly improved for both nursing and paramedical students following brief standardized educational intervention, with nursing students maintaining relatively higher knowledge levels post-intervention. These findings not only contribute valuable insights into the potential of targeted educational efforts to improve key skills among health care professionals and the effect of curriculum differences on their baseline knowledge, but also highlight how to create a more skilled and confident healthcare workforce that can boost early detection of breast cancer. The proposed intervention model offers a practical and effective strategy that could be applied across health care institutions, particularly among medical professionals, regardless of their field, to develop the confidence, commitment, and skills needed to effectively promote early detection of breast cancers in their communities. This study provides a clear road map for the curriculum reforms and implementation of effective educational intervention.

Declarations

Ethics Approval:

• This study received approval from the Ethics Committee of the Govt: Medical College, Anantnag, IEC code: IEC-GMCA/Proposal/2025/65.

Consent to Participate:

• All users voluntarily participated in sending questionnaires and signed the informed consent. All data has been treated anonymously.

Consent for Publication:

• Not applicable.

Conflicts of Interest:

• No potential conflict of interest was reported by the author(s).

Funding:

This research work was supported by Princess Nourah bint Abdulrahman University Researchers Supporting project number PNURSP2026R837, Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia.

Author Contribution

Conceptualization: S.H. and M.A.; Methodology: S.H., C.S., and J.A.; Software: J.H.; Validation: Formal analysis, S.H., and M.A.; Investigation: S.H. and C.S.; Resources: Data curation, S.H. and M.A.; Writing—original draft preparation: S.H., C.S., and J.A.; Writing—review and editing: S.H., M.A., C.S., and J.A.; Visualization: S.H., C.S., J.A., and M.A.; Supervision: S.H. and M.A.; Project administration: S.H., J.A., and M.A.; Funding acquisition: C.S.All authors have read and agreed to the published version of the manuscript.

Acknowledgement

The author would like to thank all students who participated in the study.

Data Availability

Data is not publicly available due to participant consent/limitations of the Govt: Medical College, Anantnag.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024;74(3):229–63. 10.3322/caac.21834.
2. DeSantis CE, Ma J, Gaudet MM, Newman LA, Miller KD, et al. Breast cancer statistics. CA Cancer J Clin. 2023;74(6):477–95. 10.3322/caac.21863.
3. Lei S, Zheng R, Zhang S, Wang S, Chen R, Sun K, Zeng H, Zhou J, Wei W. Global patterns of breast cancer incidence and mortality: A population-based cancer registry data analysis from 2000 to 2020. Cancer Commun. 2021;41:1183–94. 10.1002/cac2.12207.

4. World Health Organization. WHO position paper on mammography screening. Geneva: World Health Organization; 2024.
5. Karima B, Zineb S, Samir D, Othmani Mohamed B. Awareness of risk factors for breast cancer among Casablanca medical students. Asian Pac J Cancer Care. 2023;8:311–7. 10.31557/apjcc.2023.8.2.311-317.
6. Zeinomar N, Knight JA, Genkinger JM, Phillips KA, Daly MB, Milne RL, Dite GS, Kehm RD, Liao Y, Southey MC, et al. Alcohol consumption, cigarette smoking, and familial breast cancer risk: Findings from the prospective family study Cohort (ProF-SC). Breast Cancer Res. 2019;21:128. 10.1186/s13058-019-1213-1.
7. Rojas K, Stuckey A. Breast Cancer Epidemiology and Risk Factors. Clin Obstet Gynecol. 2016;59:651–72. 10.1097/GRF.0000000000000239.
8. Momenimovahed Z, Salehiniya H. Epidemiological characteristics of and risk factors for breast cancer in the World. Breast Cancer Targets Ther. 2019;11:151–64. 10.2147/BCTT.S176070.
9. Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, et al. Cancer screening in the United States: a review of current American Cancer Society guidelines and current issues in cancer screening. CA Cancer J Clin. 2019;69(3):184–210. 10.3322/caac.21557.
10. Gupta A, Shridhar K, Dhillon PK. A review of breast cancer awareness among women in India: cancer literate or awareness deficit? Eur J Cancer. 2015;51(14):2058–66. 10.1016/j.ejca.2015.07.008.
11. Jadhav BN, Abdul Azeez EP, Mathew M, Senthil Kumar AP, Snegha MR, Yuvashree G, et al. Knowledge, attitude, and practice of breast self-examination associated with general self-care and cultural factors: a study from Tamil Nadu, India. BMC Women's Health. 2024;24(1). 10.1186/s12905-024-02981-9.
12. Manzour AF, Gamal Eldin DA. Awareness about breast cancer and mammogram among women attending outpatient clinics, Ain Shams University Hospitals. Egypt J Egypt Public Health Assoc. 2019;94:26. 10.1186/s42506-019-0026-5.
13. Al-Zalabani AH, Alharbi KD, Fallatah NI, Alqabshawi RI, Al-Zalabani AA, Alghamdi SM. Breast cancer knowledge and screening practice and barriers among women in Madinah, Saudi Arabia. J Cancer Educ. 2018;33:201–7. 10.1007/s13187-016-1057-7.
14. Korkut Y. Assessment of knowledge, attitudes, and behaviors regarding breast and cervical cancer among women in Western Turkey. J Int Med Res. 2019;47:1660–6. 10.1177/0300060519830252.
15. Ghanem S, Glaoui M, Elkhoyaali S, Mesmoudi M, Boutayeb S, Errihani H. Knowledge of risk factors, beliefs and practices of female healthcare professionals towards breast cancer, Morocco. Pan Afr Med J. 2011;10:1–10. 10.4314/pamj.v10i0.72231.
16. Ibrahim NA, Odusanya OO. (2009). Knowledge of risk factors, beliefs and practices of female healthcare professionals towards breast cancer in a Tertiary Institution in Lagos, Nigeria. BMC Cancer. 76. 10.1186/1471-2407-9-76
17. Rawashdeh M, Zaitoun M, McEntee MF, Abdelrahman M, Gharaibeh M, Ghoul S, et al. Knowledge, attitude and practice regarding clinical and self breast examination among radiology professionals.

Breast Cancer Manag. 2018;7(3):BMT16. doi.org/10.2217/bmt-2018-0014.

18. Koc G, Gulen H, Ergo S, Aydin N. Breast cancer knowledge and breast self-examination practice among university students: a comparative study in Turkey. Niger J Clin Pract. 2019;22(3):410–5. 10.4103/njcp.njcp_341_18.
19. Alwan NS, Al-Diwan JKA, Al-Attar WM, Eliessa RA. Knowledge, attitude and practice towards breast cancer and breast self examination in Kirkuk University. Iraq Asian Paci J Reprod. 2012;1(4):308–11. doi.org/10.1016/S2305-0500(13)60098-6.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryfile1.docx