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# Evaluating the Impact of a Structured Health Education Campaign on Breast Cancer Awareness, Knowledge, and Attitudes Among Undergraduate Medical Students: A Quasi-Experimental Study

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## Abstract

# Background:

Although future physicians have an important role in early detection, counselling and community awareness, breast cancer education is still lacking in many undergraduate medical curricula in Pakistan. The study was aimed at evaluating the effect of structured educational intervention on breast cancer awareness, knowledge and attitude among MBBS students and to compare the baseline differences according to academic phase and gender

# Methods:

A pre-post single-center quasi-experimental study was conducted among 252 undergraduate MBBS students of Nowshera Medical College, Pakistan. Structured educational intervention (standardised seminar, instructional video, and pamphlets) was provided. Knowledge and attitudes were measured immediately before and 2 weeks after the intervention using a validated 16-item Likert scale questionnaire. Primary outcomes Overall mean changes in knowledge-and-attitude scores. Secondary outcomes Changes in item-level scores; comparisons of knowledge and attitude by academic phase and gender using t-tests, linear regression and ROC analysis.

# Results:

Of 252 participants who participated in the pre-test, only 251 completed the post-test. Clinical-year students and female students scored significantly higher than pre-clinical students and male students respectively at baseline. There was a significant increase in the overall mean knowledge-and-attitude score at post-test compared with pre-test (mean increase = 0.17, p = 0.002) with a small effect size (Cohen's d = 0.193) after the intervention. Most improvement was observed in practical aspects such as components of triple assessment and BSE instruction, but shortcomings persisted post-test in screening guidelines and perceived curriculum adequacy

# Conclusion:

Small but statistically significant improvements in breast cancer awareness were observed among medical students following a brief, formal educational session. Our results suggest that formalised breast oncology, defined screening guidelines and breast examination should be incorporated into the practical undergraduate curriculum.

## INTRODUCTION:

Breast cancer remains a major public health challenge and is the world's most frequently diagnosed malignancy among women, surpassing lung cancer. Characterized by uncontrolled growth of breast cells, breast cancer contributed to an estimated 2.3 million new cases and approximately 685,000 deaths affecting

women across the world as per GLOBOCAN 2020 [1]. In addition, it is a major cause of disability and premature deaths among women, substantially contributing to disability-adjusted life years (DALYs), reflecting its considerable clinical, social, and economic burden [2].

Pakistan bears a disproportionately high burden of breast cancer, affecting an estimated one in nine women during their lifetime [3]. Although the incidence is generally higher in high-income countries, mortality remains disproportionally greater in low- and middle-income countries (LMICs) [4]. This is due to the fact that women in low-resource settings often present at more advanced stages of the disease, which delays diagnosis, limits treatment opportunities, and thereby reduces survival. Consequently, there is a critical need for such strategies that promote early detection [5].

As the prognosis of the disease is highly stage-dependent, serious complications arise with delayed diagnosis [6]. Therefore, programs developed to promote early detection and prompt management play a pivotal role in reducing mortality and morbidity. Strategies to promote early diagnosis include breast cancer awareness campaigns and screening modalities such as population-based mammography, clinical breast examination (CBE), and breast self-examination (BSE) in order to facilitate early diagnosis and promote timely treatment [7]. However, in low- and middle-income countries, the awareness and use of these techniques are limited [8]. This is attributed to the lack of awareness and other sociocultural barriers such as stigma, fear, and inadequate health education that discourage women from seeking appropriate medical treatment [9, 10].

In order to address knowledge gaps and promote preventive health behaviors, educational strategies are so far considered to be the most successful way. Structured brief training programs, collaborative online workshops, and mini-lectures conducted across various educational settings markedly improved students' knowledge and confidence in breast health education [11–13]. An interventional study conducted in Karachi reported significant results, with a 2.6-fold increase in the proportion of participants demonstrating a correct understanding of breast self-examination following the intervention [14]. These findings collectively support the notion that structured educational interventions are practical and effective strategies for improving breast cancer awareness among future healthcare professionals.

As future physicians, medical students are an important target population for breast cancer awareness interventions because they will play an important role in patient counseling, community awareness, and the promotion of evidence-based early detection practices. Strengthening their knowledge, attitude, and clinical competency will contribute to public awareness of early detection and treatment of breast cancer [15]. As per previous studies, there is a significant gap in medical students' knowledge about breast cancer symptoms, risk factors, and breast self-examination practices despite the fact that they receive undergraduate medical education and clinical training [16]. A survey revealed that the Pakistani female university students lacked knowledge regarding the risk factors of breast cancer and the screening methods [17]. These findings support future breast cancer awareness initiatives to strengthen medical students' knowledge and their capacity to advocate for early detection.

Although most of the previous studies have assessed breast cancer awareness levels among medical students in Pakistan, there is limited evidence on the effectiveness of structured educational intervention [18]. Addressing this gap is important for informing medical education and future public health programming.

Therefore, the present study evaluates the overall effectiveness of a structured educational intervention on breast cancer awareness among MBBS students at Nowshera Medical College using pre- and post-test results. It further compares baseline knowledge between preclinical students (1st–2nd year) and clinical students (3rd–5th year) to identify where educational reinforcement may be most needed. Additionally, it will help bridge the knowledge gap and empower medical professionals to make well-informed decisions and collaborate to improve women's breast health.

## Materials and Methods:

# Study site and study design:

This single group, pre-post quasi-experimental study was conducted at Nowshera Medical College, Nowshera, Khyber Pakhtunkhwa, Pakistan. The objective of this study was to assess the outcome and significance of a structured educational seminar on breast cancer related knowledge, attitude and diagnostic practices among undergraduate pre-clinical and clinical MBBS students. Data collection took place over a nearly two month period following approval from the Ethical Review Board (ERB) of Nowshehra Medical College (Ref No. No: ERB-U / APP / 2026 / 33). All methods were carried out in accordance with the Declaration of Helsinki. A single-group pre-test, intervention and post-test design was applied to evaluate changes in baseline scores two weeks after the educational seminar was conducted.

## Inclusion criteria:

Participants included currently enrolled undergraduate MBBS students in first through final year at Nowshera Medical College, aged 18–30 years, and willing to provide informed consent.

## Exclusion criteria:

Exclusion criteria were absence and failure to complete any of the three study phases (pre-test, educational session, or post-test), prior clinical experience in oncology or prior participation in breast cancer awareness training, and resistance to participation at any stage of study.

## Ethical considerations:

**Ethical approval**

was obtained from the Ethical Review Board of Nowshera Medical College prior to study initiation. Ethical considerations were emphasized throughout this study. The ERB approval ensured adherence to ethical guidelines, and the participants' right to privacy and voluntary participation were upheld. Administrative permissions to conduct educational seminar sessions and surveys were also obtained. All participants received verbal and written information about the study objectives and procedures and provided written informed consent. Participation was voluntary and responses were strictly anonymous.

## Questionnaire development and validation:

A structured questionnaire was developed to assess breast cancer awareness, including elements on demographics, epidemiology, knowledge of risk factors, recognition of symptoms and warning signs, familiarity with screening methods (BSE, CBE, and mammography), attitudes toward screening and socio-cultural restrictions, and self-reported practices.

Content validity was evaluated by expert clinicians and public health academics. Reliability of the questionnaire was assessed by calculating Cronbach's alpha for the knowledge and attitude domains during pilot testing. A pilot study was conducted with a sample size of 16 and those participants were not included in the final analysis to test clarity, face validity, and timing. Some required adjustments in format and wording were made accordingly (Cronbach's alpha = 0.857).

# Sample size and sampling technique

The study population consisted of medical students across pre-clinical (first and second years) and clinical (third, fourth, and fifth years) phases. A total of 252 students participated in the study. Participants were recruited at an awareness symposium at Nowshera Medical College. Convenient sampling was applied to specify respondent numbers equal from each academic year unless the target sample size was reached. Students absent from any study phase or meeting exclusion criteria were not included.

## Data collection and procedure

# Baseline questionnaire administration

Consenting participants (N = 252) completed baseline (pre-test) questionnaires distributed electronically immediately prior to the educational session. The pre-test compiled demographic information (age, gender, academic year) and baseline measures of 16 Likert-scale knowledge and attitude items.

# Educational intervention

The educational intervention, composed of standardized 45-minute awareness seminar sessions delivered by qualified instructors, supplemented by a 7-minute informational video displaying the proper steps of breast self examination (BSE) and distribution of informational pamphlets. The seminar covered four core areas. Firstly, breast cancer epidemiology, highlighting its high incidence in Pakistan. Then clinical presentations (common risk factors, protective factors, clinical signs and symptoms) were covered. Lastly, recommended screening methods and appropriate ages/timings for screening, steps of breast self-examination (BSE), and culturally sensitive ways to promote breast health were addressed. The presentation, instructional video, and teaching script were identical for all sessions to ensure consistency across all groups. The pre- and post-session surveys used in this research were based on those utilized in related earlier investigations.

# Post-session survey

Participants were asked to fill the post-test questionnaire two weeks after the educational session. The post-test was the same as the pre-test, which included the same 16 Likert scale knowledge and attitude items, but

did not repeat the demographic items to save time. Each participant was given a unique study number at the time of the pre-test to ensure correct matching of pre- and post-responses, while preserving anonymity. One participant who completed the pre-test did not return the post-test, yielding 251 paired post-test records for analysis. The within-subject comparisons of change in individual item scores were possible with the pairing of item scores and an overall mean knowledge-and-attitude score, calculated from the 16 Likert-scale items used as the main outcome measure.

# Statistical analysis

Data were analyzed in IBM SPSS version 27.0. Descriptive statistics (frequencies, means and standard deviations) were used to summarize the demographics and item scores. Internal reliability was tested with Cronbach's alpha. The main outcome was the overall mean knowledge-and-attitude score on the 16 Likert-scale items. Changes in the overall mean scores between the pre-test and post-test were analyzed using paired sample t-tests, and Cohen's d was used to measure effect sizes. Independent samples t-tests were performed to compare baseline scores across study phase (pre-clinical vs. clinical) and gender (male vs. female). When variances were unequal, degrees of freedom were adjusted with Levene's test for equality of variances. Separate multiple linear regression models were used to determine if academic year and gender predicted the scores for pre-test and post-test data reporting unstandardized coefficients (B), standardized coefficients (beta), $R^2$, adjusted $R^2$ and F-test significance values.

Finally, Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the predictive accuracy of overall mean score in comparison to total raw post-test knowledge score. The AUC and 95% CI were calculated for both, and the two AUCs were compared using a paired sample area difference test (z-test). All tests were conducted with a two-tailed *p*-value of less than 0.05 ($p < 0.05$) for statistical significance.

## RESULTS:

The pre-test comprised 252 participants which included 80 male students and 171 female students in which 98 were clinical (students of $3^{rd,}4^{th\ and}$5th year) and 154 were pre-clinical students (students of 1st 2nd year). One participant was lost to follow up which resulted in a sample of 251 for our post-test. The main outcome was the overall mean knowledge and attitude score (based on 16 Likert-scale items). We analyzed data using independent samples t-tests, multiple linear regression, paired samples test, descriptive statistics in SPSS. Findings of the tests are shown in Tables 1–6.

# COMPARATIVE ANALYSIS BY GENDER AND PHASE OF STUDY:

# PHASE OF STUDY:

At pre-test, independent samples t-test (Table 1) revealed significantly higher scores by clinical students ($n$ = 98, M = 3.62, SD = 0.48) than pre-clinical students ($n$ = 154, M = 3.33, SD = 0.62); ($t(241.465) = -4.084$, $p < 0.001$, Cohen's d = -0.49), indicating good breast cancer knowledge and favorable attitude towards breast cancer by clinical students due to their clinical exposure. After the intervention, both pre-clinical and clinical students benefited from the intervention as confirmed by the paired samples t-test results (Table 6) which showed a

significant improvement from pre to post-test ($p$ = 0.002), demonstrating the effectiveness of intervention across all levels of medical education.

Table 1
T-TEST FOR OVERALL MEAN KNOWLEDGE AND ATTITUDE SCORES COMPARISON BY PHASE OF STUDY. (PRE-TEST)

| Variable | Group | N | Mean | SD | t | df | *p*-value | Mean difference | 95% CI | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|---|
| **Phase of study** | **Pre-clinical year** | 154 | 3.33 | 0.62 | -4.08 | 241.465 | < 0.001 | -0.28 | -0.42, -0.14 | -0.49 |
| | **Clinical year** | 98 | 3.62 | 0.48 | | | | | | |

# GENDER:

At pre-test, independent samples t-test (Table 2) revealed significantly higher scores by female students ($n$ = 171, M = 3.55, SD = 0.51) than the male students ($n$ = 80, M = 3.22, SD = 0.67), with a moderate baseline gap (t(122.874) = -3.898, $p$ < 0.001, Cohen's d = -0.58). After intervention, the gender gap closed successfully for 10 of the 16 items related to screening guidelines, some of the clinical presentations such as painless lump and peau d'orange; diagnostic skills such as outlining triple assessment components and teaching Breast self examination (BSE); curriculum awareness; professional preparedness to perform Clinical breast examination (CBE); reliance on traditional healers; epidemiological awareness and educational impact of seminars (all with $p$ > 0.05). This shows the effectiveness of intervention in helping male students catch up with their female counterparts on these topics. However, for six items related to lifestyle risk factors, breastfeed protects against malignancy, clinical presentation and signs such as unilateral bloody nipple discharge; axillary lymphadenopathy and socio-cultural barriers such as cultural modesty and fear of mastectomy, female students still scored higher than male students (Table 3).

Table 2
PRE-TEST GENDER COMPARISON FOR OVERALL MEAN KNOWLEDGE AND ATTITUDE SCORE. (T-TEST)

| Variable | Group | N | Mean | SD | t | df | *p*-value | Mean difference | 95% CI | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gender** | **Male** | 80 | 3.22 | 0.67 | -3.89 | 122.874 | < 0.001 | -0.33 | -0.49, -0.16 | -0.58 |
| | **Female** | 171 | 3.55 | 0.51 | | | | | | |

Table 3
POST-TEST 6 ITEMS SCORE BY GENDER. (T-TEST)

| ITEM | t | df | *p*-value | Mean difference | 95% CI | Cohen's d |
|---|---|---|---|---|---|---|
| **Sedentary lifestyle/high BMI as contributor** | -2.228 | 137.299 | 0.028 | -0.339 | -0.640, -0.038 | -0.317 |
| **Breastfeed-protects** | -2.637 | 130.106 | 0.009 | -0.411 | -0.719, -0.103 | -0.384 |
| **Nippledischarge- as a sign** | -2.323 | 249 | 0.021 | -0.325 | -0.601, -0.049 | -0.315 |
| **Axillary-lymphadenopathy-as presentation** | -2.432 | 131.868 | 0.016 | -0.378 | -0.686, -0.071 | -0.352 |
| **Cultural-modesty** | -2.533 | 127.912 | 0.013 | -0.428 | -0.762, -0.094 | -0.372 |
| **Fear of mastectomy** | -2.558 | 134.725 | 0.012 | -0.371 | -0.658, -0.084 | -0.367 |

# PREDICTORS OF BREAST CANCER KNOWLEDGE AND ATTITUDE SCORE:

Table 4 represents the pre- and post-test results of multiple linear regression with year of study and gender predicting the overall mean knowledge and attitude score.

At pre-test, the model was statistically significant ($F = 11.676$, $p < 0.001$) and it explained 8.6% of the variance ($R^2 = 0.086$). Gender resulted in stronger effect ($B = 0.251$, $\beta = 0.199$, $p = 0.004$), the year of study also contributed to the model ($B = 0.173$, $\beta = 0.144$, $p = 0.034$), indicating that female students and those of clinical years have higher level of knowledge and favorable attitude towards breast cancer. At post-test, the model was statistically significant ($F = 30.203$, $p < 0.001$) and it explained 19.6% of variance ($R^2$ of 0.196), with year of study becoming strong predictor ($B = 0.233$, $\beta = 0.419$, $p < 0.001$) than gender ($B = 0.289$, $\beta = 0.180$, $p = 0.002$), demonstrating that intervention further increased clinical students in their breast cancer knowledge and attitudes. The model predictive power more than doubled post-intervention ($R^2 = 0.196$ vs 0.086) which is suggestive of intervention's amplified effects on clinical training and it helped students in extending their clinical knowledge.

Table 4
PREDICTORS OF OVERALL MEAN KNOWLEDGE AND ATTITUDE SCORE. (REGRESSION ANALYSIS OF PRE AND POST-TEST)

| Predictor | PRE-TEST | POST-TEST |
|---|---|---|
| **$R^2$** | **0.086 (8.6%)** | **0.196 (19.6%)** |
| **Adjusted $R^2$** | **0.079** | **0.189** |
| **Model significance** | F = 11.676, $p < 0.001$ | F = 30.203, $p < 0.001$ |
| **Year of study** | B= 0.144, $p = 0.034$, | B= 0.419, $p < 0.001$ |
| **Gender** | B= 0.199, $p = 0.004$ | B= 0.180, $p = 0.002$ |

# DESCRIPTIVE STATISTICS OF KNOWLEDGE AND ATTITUDE ITEMS:

The descriptive analysis revealed different awareness levels across different domains of knowledge and attitude items by 252 pre-test and 251 post-test participants. (shown in Table 5)

# PRE-TEST HIGHEST TO LOWEST SCORES:

At pre-test, the highest score was observed for **'Awareness seminars/workshop bridge knowledge gap'** (M = 3.98, SD = 1.07) which decreased to (M = 3.86, SD = 1.15) at post-test. This is possibly due to the ceiling effect as pre-test scores were already high and this small decrease could be due to more realistic assessment of the situation following a real educational intervention. This was followed by **' Cultural modesty and shyness delay seeking breast care'** (M = 3.87, SD = 1.19), which slightly increased to (M = 3.92, SD = 1.16) at post-test, indicating that the intervention was quite helpful in increasing the awareness of socio-cultural barriers. The lowest score was for **'Current MBBS curriculum provides sufficient exposure to breast oncology**' (M = 2.62, SD = 1.08) which slightly increased to (M = 2.80, SD = 1.15) at post-test, but remained among the post-test low score, showing that students still perceive their curriculum lacks adequate breast oncology content. Another lowest score at pre-test was for **'Can outline components of triple assessment'** (M = 2.89, SD = 1.10) which showed the largest improvement and increase at post-test to (M = 3.24, SD = 1.16). This demonstrates that intervention was particularly helpful in teaching of clinical diagnostic skills such as triple assessment.

# POST-TEST HIGHEST TO LOWEST SCORES:

At post-test, the highest score was observed for **'Breast cancer is most common malignancy in Pakistan'** (M = 3.98, SD = 1.15), reflecting intervention's role in increasing epidemiological knowledge by students, followed by **'Delay due to mastectomy fear'** (M = 3.94, SD = 1.02), suggesting a good post-intervention awareness of barriers related to treatment seeking. The lowest score was **'understand breast cancer screening guidelines'** (M = 2.76, SD = 1.16), this indicates that students remained confused about when or how to screen patients for breast cancer, suggesting a more focused teaching about screening guidelines in future educational sessions. Another lowest score was for **'Current MBBS curriculum provides sufficient exposure to breast oncology**' (M = 2.80, SD = 1.15).

Overall the intervention improved the breast cancer knowledge and attitude across multiple areas and scores increased from pre- to post-test for epidemiological awareness such as breast cancer as most common malignancy, clinical presentation and signs such as bloody nipple discharge; peau d'orange; painless lump; axillary lymphadenopathy, risk factor understanding such as sedentary lifestyle/ high BMI and breastfeeding is protective, clinical preparedness such as performing Clinical breast examination (CBE); teaching Breast self examination (BSE); treatment barriers such as fear of mastectomy; reliance on traditional healers. However, gaps persisted in screening guidelines understanding and curriculum adequacy, highlighting areas for further reinforcement. (Table 5)

Table 5
PRE TO POST CHANGE IN KNOWLEDGE AND ATTITUDE SCORES. (FINDINGS OF DESCRIPTIVE ANALYSIS)

| ITEM | PRE-TEST MEAN (SD) | POST-TEST MEAN (SD) |
|---|---|---|
| **Breast cancer is most common malignancy in Pakistan** | 3.65 (1.08) | 3.98 (1.14) |
| **Sedentary lifestyle and high BMI as contributors** | 3.45 (0.96) | 3.78 (1.07) |
| **Painless hard breast lump is a presentation** | 3.62 (1.04) | 3.83 (1.10) |
| **Breastfeeding protects against malignancy** | 3.61 (1.03) | 3.89 (1.08) |
| **Unilateral bloody nipple discharge is suggestive of breast cancer** | 3.55 (0.98) | 3.90 (1.04) |
| **Structural skin changes (peau d'orange)** | 3.71 (0.99) | 3.92 (1.05) |
| **Axillary lymphadenopathy as presentation** | 3.58 (0.93) | 3.83 (1.08) |
| **Teaching Breast Self Examination (BSE)** | 2.97 (1.20) | 3.25 (1.167) |
| **Can outline triple assessment components** | 2.89 (1.10) | 3.24 (1.16) |
| **Cultural modesty delays seeking care** | 3.87 (1.19) | 3.92 (1.16) |
| **Delay due to mastectomy fear** | 3.73 (1.01) | 3.94 (1.02) |
| **Reliance on traditional healers as hurdle** | 3.70 (0.93) | 3.77 (1.08) |
| **Prepared as future doctor to perform Clinical Breast Examination (CBE)** | 3.10 (1.15) | 3.20 (1.11) |
| **Understand breast cancer screening guidelines** | 2.97 (1.14) | 2.76 (1.16) |
| **Awareness seminars bridge knowledge gap** | 3.98 (1.07) | 3.86 (1.15) |
| **Current MBBS curriculum provides sufficient exposure to breast oncology** | 2.62 (1.08) | 2.80 (1.15) |

**COMPARATIVE ANALYSIS: PRE VS POST-INTERVENTION.**

To compare overall mean knowledge and attitude score before and after the intervention, we performed a paired samples t-test (Table 6). The results revealed that there is a significant increase in knowledge and

attitude scores from pre-test to post-test (t = -3.062, *p* = 0.002). The mean difference is -0.1746 (95% CI: -0.2869 to -0.0622), with a small effect size (Cohen's d = -0.193, 95% CI: -0.318 to -0.068), showing that the intervention was effective.

Table 6
COMPARISON OF PRE-POST OVERALL MEAN KNOWLEDGE AND ATTITUDE SCORE. (PAIRED SAMPLES TEST)

| PAIR | Mean difference | SD | t | df | *p*-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|---|---|
| **Overall mean knowledge and attitude score-overall post score** | -0.1746 | 0.903 | -3.062 | 250 | 0.002 | -0.286, -0.062 | -0.193 |

# DISCUSSION:

This quasi-experimental study assessed the impact of the structured educational intervention on breast cancer awareness among 252 medical students at Nowshera Medical College, Pakistan. Breast cancer is one of the most fatal and leading diseases occurring among women. It is very common in high, middle and low income countries but ultimately results in higher mortality in third world countries due to ignorance, late diagnosis and inadequate medical facilities [4]. Keeping this in view, the medical knowledge dealing with breast cancer, of clinical and preclinical students was evaluated in this study. This study was carried out in three phases. Initially, a pre-tested questionnaire was administered among the students attending the breast cancer awareness symposium. The questionnaire was specifically designed to assess the baseline knowledge of medical students regarding breast cancer. The results of the pre-test highlighted the strengths and the areas that demanded attention with regard to the topic. Next, the intervention was carried out at the same symposium which imparted both theoretical and practical knowledge to the participants. Finally, the same pre-test questionnaire was administered as post-test questionnaire two weeks after the intervention to assess its impact. This discussion not only interprets important results, which are along the lines of existing literature, but also critically assesses the study's methodological considerations, including the use of Receiver Operating Characteristic ( ROC ) analysis, the limitations of a quasi-experimental design and the study's implications for medical curriculum, clinical practice and community health promotion. The outcomes of the research provided valuable evidence of improvement, from epidemiological awareness to clinical diagnostic skills hence reinforcing the value of such targeted awareness programs in a resource-limited setting like Pakistan, where breast cancer incidence is constantly rising [19].

The findings of the study should be interpreted within the framework of Bandura's Social Cognitive Theory, which guided the study. Bandura's Social Cognitive Theory focuses on the importance of learning by observation, self-reliance, and reciprocal determinism in behavioural change [20]. Questions that were most directly related to observational learning were teaching patients the correct step-by-step technique for a monthly Breast Self-Exam (BSE), outlining the components and clinical application of a 'Triple Assessment' and being prepared to confidently conduct clinical breast examination.

It was clear from the pre-test that clinical students had higher baseline knowledge of breast cancer than preclinical students ($p < 0.001$). This is presumably associated with the increased clinical experience and integrated oncology education that students obtained in the later years of the medical school. Qasim et al.

identified a knowledge spectrum based on years of study and clinical experience by reporting that clinical-year medical students at King Edward Medical University, Lahore had significantly higher knowledge scores (7.8 ± 2.9) compared to preclinical students (5.5 ± 3.2) [16]. Similarly, Damascus University researchers found that clinical-stage students had a significantly better awareness of predisposing variables, clinical symptoms, and were better able to establish screening frameworks for breast cancer [21]. These outcomes clearly reveal the core importance of clinical placements, patient interactions, and integrated teaching in putting into practice theoretical knowledge to bedside skills.

Interestingly, the analysis revealed that the largest post-intervention improvement occurred in knowledge of "Triple Assessment" components (increase from M = 2.89 to M = 3.24). This demonstrated that educational interventions can promote preventative health behaviors, particularly when students have practical contexts in which to apply new knowledge [22]. Exceptional improvement in clinical competence, for example, the ability to teach Breast-Self Exam (BSE) ( M = 2.97 to M = 3.25) and perform clinical breast examination (from M = 3.10 to M = 3.20), proves the intervention's efficacy in improving practical skills that students can apply in clinical settings (Figs. 1 & 2).

The high baseline awareness of socio-cultural barriers (M = 3.87 and M = 3.92) confirmed that women mostly deter from receiving cancer treatment due to cultural norms, social stigma, limited health service access, nosophobia and fear of mastectomy, which ultimately leads to delayed diagnosis and malignancy of the tumor [22].

The gender gap apparent in the pre-test phase ($p < 0.001$) substantially attenuated post-intervention, resolving for 10 out of 16 indicators. Differences persisted among modifiable risk factors, disease manifestations, and socially and culturally embedded obstacles, where male students demonstrated lower knowledge scores compared to their female counterparts. Similarly, in a previously conducted research in Pakistan, it was reported that female medical students and hospital employees had a significantly better understanding of risk factors and breast self-exam than their male colleagues [23]. It could be attributed to multiple factors such as higher occurrence of the disease among females so they had more knowledge, greater societal exposure, and due to the cultural sensitivities in Pakistan, where open discussion of breast health is discouraged, particularly with men, limiting their opportunities for informal learning and reducing their comfort with breast cancer-related topics [22].

In spite of the intervention's success in clinical competence, gaps persisted in screening guidelines and curriculum adequacy, highlighting areas for further reinforcements. Screening recommendations resulted in the lowest mean post-intervention score (M = 2.76, SD = 1.16). Students continued to struggle with when and how to screen patients for breast cancer. Only a few knew the correct age to start breast cancer screening and that mammography is the screening modality [17] [24]. Furthermore, the students believed that the curriculum did not adequately cover breast oncology (M = 2.62 pre-test, M = 2.80 post-test). Likewise, Syrian medical students lacked knowledge for raising community awareness regarding breast cancer [21].

The results of this study indicated that the educational intervention made significant improvements in mean knowledge and attitude scores from pre to post-intervention ($t(250) = -3.062$, $p = 0.002$), but the effect size remained small (Cohen's d = -0.193, 95% CI: -0.318 to -0.068) (Fig. 2). While the effect size appears to be low, it is consistent with findings from other educational campaigns in Pakistan and similar settings. The smaller

effect size in this study can be explained by the higher baseline knowledge of breast cancer among medical students relative to pharmacy students, indicating a ceiling effect [14].

Figure. 3 shows the ROC curve, which was used to estimate the prediction accuracy of post-test results. The total mean knowledge and attitude score had modest predictive power (AUC = 0.632), accurately predicting around 63.2% of the instances. The overall post-knowledge score had weak prediction performance (AUC = 0.495) and was close to chance level. A paired sample area difference test indicated a statistically significant difference between the two AUCs (z = -2.614, *p* = 0.009), with a difference in AUCs of -0.138 (95% CI: -0.241 to -0.034), confirming the overall mean knowledge and attitude score as a better main outcome measure. This outcome implies that combining both knowledge and attitudes gives a more comprehensive measure of breast cancer awareness than just knowledge, which supports the questionnaire's multidimensional design.

# Implications:

This study's findings have important implications for Pakistan's medical education and public health system. The baseline knowledge gaps and perceived inadequate curricular exposure necessitate systematic inclusion of breast oncology and screening guidelines within the medical curriculum, along with practical teaching of breast self-examination and clinical breast examination in both pre-clinical and clinical years of medical education. The ineffective response regarding screening guidelines despite the intervention requires focused attention through case-based practical learning and decision-making guidelines. Improvement in Triple Assessment knowledge revealed the value of well-regulated teaching in enhancing clinical diagnostic skills. Noticeable recognition of socio-cultural obstacles requires interventions to directly confront the challenges related to women's breast health, examination and treatment through community outreach with cultural acceptability—acknowledging the patient’s preferences for female healthcare providers.

# Limitation:

There are several limitations to this study. First, the use of self-reported questionnaire responses may have introduced social desirability and response bias, as participants may have overestimated their knowledge or attitudes. Second, the single-center design at Nowshera Medical College may limit the generalizability of the findings to students from other Pakistani medical colleges with different academic, demographic, and sociocultural characteristics. Third, although paired within-subject pre- and post-intervention comparisons were performed, the absence of a control group limits causal inference, as changes in scores may have been influenced by other academic, clinical, or contextual factors occurring during the study period. Fourth, the post-intervention assessment was conducted only two weeks after the educational session; therefore, the study could not determine whether the observed knowledge and attitude gains were sustained over the longer term or translated into changes in clinical practice or patient counselling. Finally, the observed effect size was small (Cohen’s d = 0.193), suggesting that although the improvement was statistically significant, its practical educational magnitude may have been modest. Future multicenter studies with controlled or randomized designs and longer follow-up periods are needed to assess the durability and broader educational impact of such interventions.

# Future Directions:

Future research should employ randomized control trials to establish causality and longitudinal studies with 6–12 month follow-ups to assess long-term knowledge gain and behavioral changes adopted, such as for Breast Self Exam practice, patient counselling and triple assessment. To ensure generalizability, research should be carried out at various medical colleges of Pakistan, which would enable clinical comparisons. Validated instruments should be used for measurement of accuracy. Other traits attributing to breast cancer, such as genetic predisposition, previous awareness seminars, and cultural perspectives, could improve model accuracy. Interventions should address gender-specific gaps; for example, screening criteria require RCT evaluation. Comparative studies across medical and non-medical students could highlight the true success of training.

## Conclusion:

This quasi-experimental study highlights the success of the structured educational intervention in improving breast cancer awareness among medical students at Nowshera Medical College, Pakistan (Fig. 2). The findings of this study show baseline knowledge disparities by gender and year of study, as well as the need to revise the curriculum to incorporate comprehensive breast health education. Furthermore, there is a need to organise intervention and culturally sensitive programs to specifically target male students and to address socioeconomic hurdles respectively. Structured educational interventions can equip future doctors to lead the fight against breast cancer in Pakistan, resulting in earlier detection, fewer deaths, and better public health outcomes. As the breast cancer prevalence rises in third-world nations, investing in medical education is a realistic way to improve health outcomes in these high-risk populations.

## Abbreviations

- **CI**

Confidence Interval

- **AUC**

Area Under the Curve

- **OR**

Odds Ratio

- **ROC**

Receiver Operating Characteristic

- **NMC**

Nowshehra Medical College

- **SD**

Standard Deviation

- **SPSS**

Statistical Package for the Social Sciences

## Declarations

# Ethics Approval and Consent to Participate:

This study was approved by the Ethical Review Board (ERB) of Nowshehra Medical College (Reference No: ERB-U / APP / 2026 / 33 ). Informed consent was obtained electronically from all participants before their involvement in the study. All methods were carried out in accordance with the Declaration of Helsinki.

## Consent for Publication:

Not applicable. The manuscript does not contain any individual data in any form (including individual details, images, or videos).

## Competing Interests:

The authors declare no competing interests.


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## Author Contribution

1. Abdul Basit – Conceptualization, Study design, Supervision, Manuscript writing, Final approval of manuscript.2. Marriyum Rashid Khan – Statistical analysis, Interpretation of results, Graphs and tables preparation.3. Muskan Waheed – Data collection, Data curation, Literature review, Initial draft preparation.4. Manail Humayun– Questionnaire adaptation, Validation, Reliability assessment, Participant recruitment, Data collection.5. Ayesha Fiaz Ud Din– Review and editing of manuscript, Critical revisions for intellectual content, Data collection.6. Minahil Iman Janjua—Manuscript Writing and Prepared Figures7. Tania Khattak- Manuscript Writing 8. Abdullah Saram- Revision, compilation and Submission


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## Data Availability

All data generated or analysed during this study are included in this published article

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# Figures

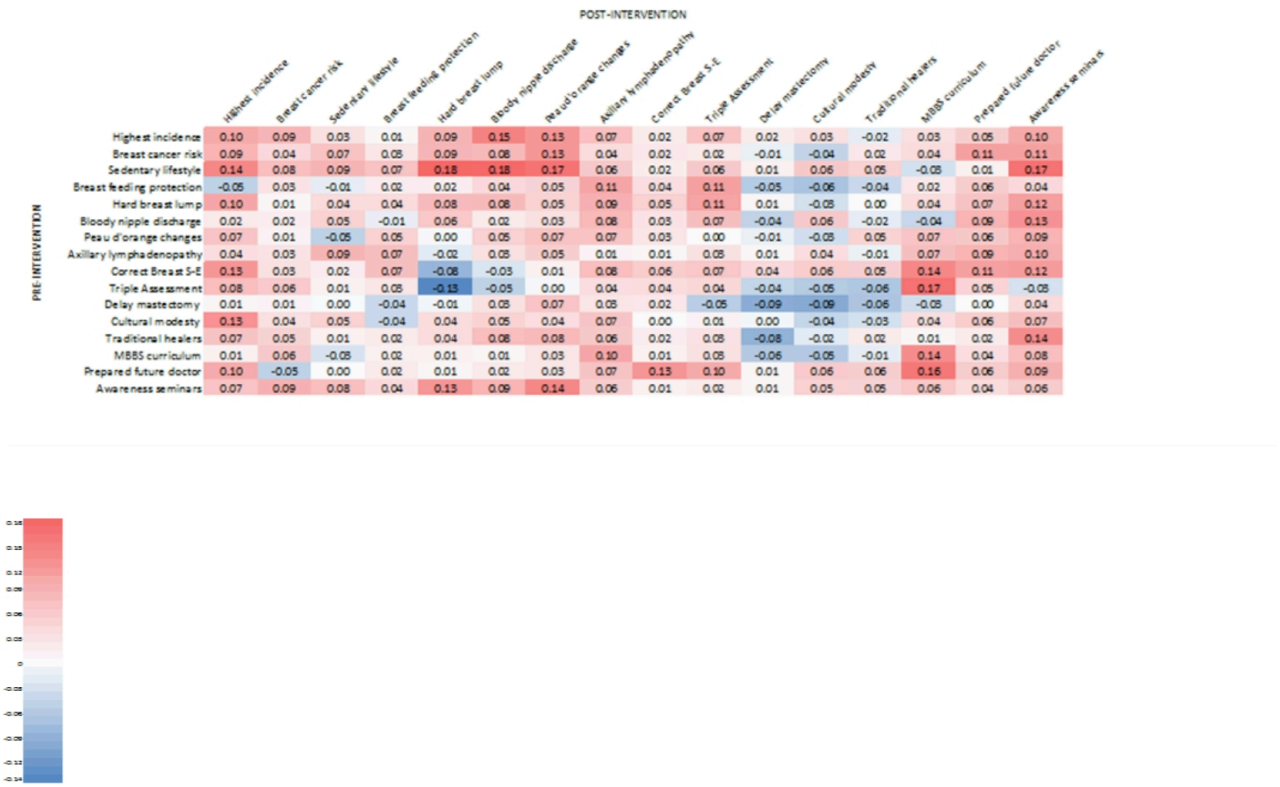



**Figure 1**

Correlation heatmap depicting the pairwise relationships between breast cancer knowledge, attitude, and awareness variables among medical students. The color gradient represents Pearson correlation coefficients, with red indicating positive correlations and blue indicating negative correlations. There were significant positive associations between breast cancer knowledge scores and attitudes towards screening (r = 0.293, *p* = 0.05), as well as between overall awareness scores and self-reported practice behaviours. However, weak association was found between specific knowledge domains for example, risk factors and clinical presentation, indicating that students' understanding of intervention varied.

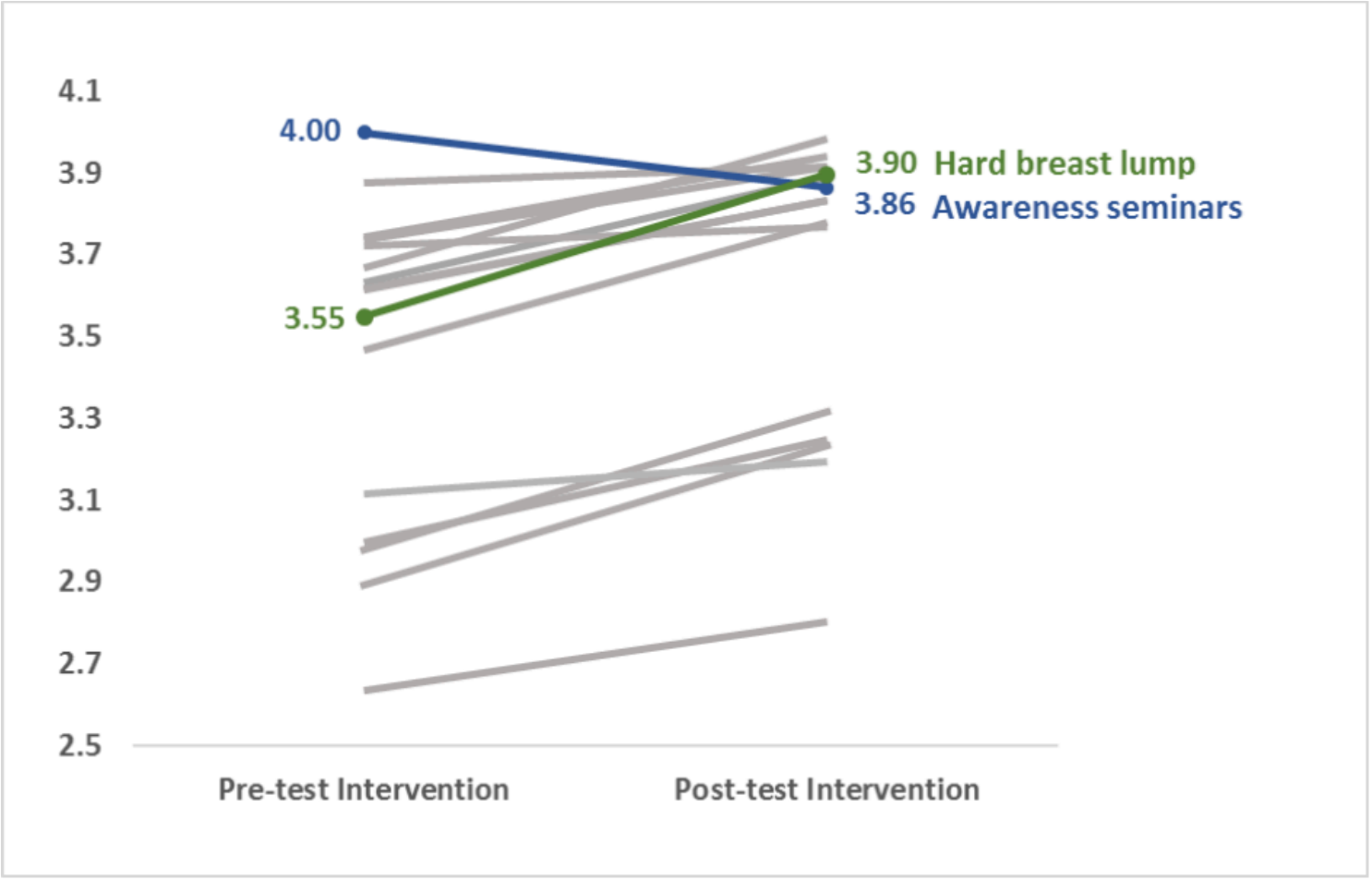



**Figure 2**

A bar chart comparing pre-test and post-test mean scores in breast cancer awareness subject areas among medical students. The pre-test scores (3.55 to 4.00) and post-test scores (3.55 to 3.90) represent students' knowledge, attitudes, and overall awareness of breast cancer prior to and following a planned educational intervention. The overall mean knowledge and attitude score improved from 3.55 at baseline to 3.86 at post-intervention, showing that the training program had a favorable impact on breast cancer awareness. While most categories showed modest gains, some showed minimal change, implying misapprehension of the intervention.

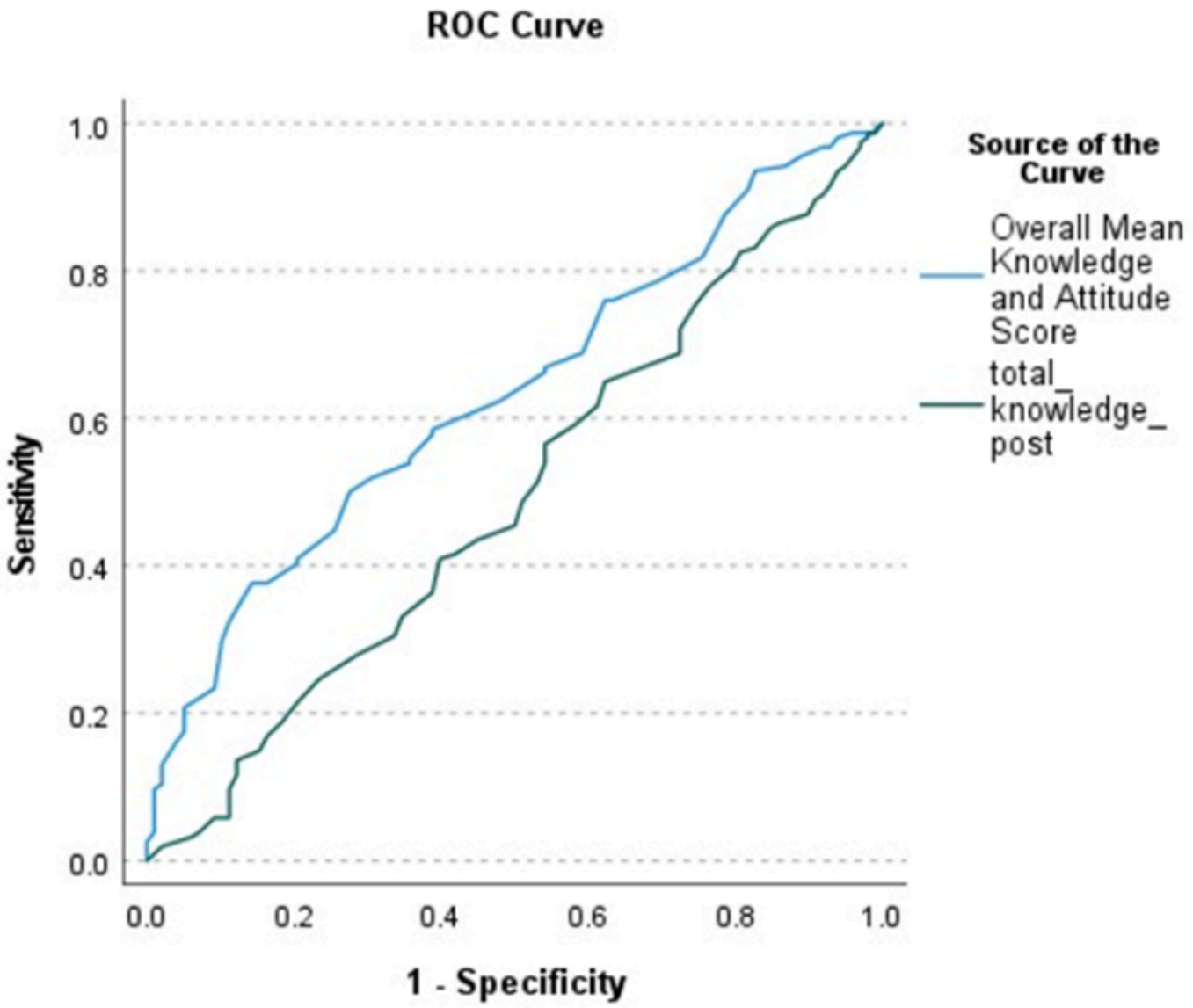



**Figure 3**

Receiver Operating Characteristic (ROC) curves for the logistic regression models that predict breast cancer awareness among NMC medical students based on the average knowledge and attitude scores of 252 medical students. Model performance is indicated by the Area Under the Curve (AUC) values, which plot sensitivity versus 1-specificity. While the knowledge_post model (AUC = 0.495) performed at a level near chance, indicating weak discriminative power, the total mean knowledge and attitude score model (AUC = 0.632) showed moderate predictive ability.

## Supplementary Files

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

- BreastCancerAwarenessQuestionnaire.docx
- AbdulBasitapprovalERB33.pdf
- responsetoreviewers.pdf