Effectiveness of face to face and virtual education to promote breast self-examination based on the theory of planned behavior: a randomized controlled trial study

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Abstract

Background Breast cancer (BC) is the most prevalent cancer among women in both developed and developing countries. Breast self-examination (BSE) is crucial for the early detection of BC. This study aimed to assess the effectiveness of face-to-face and virtual education on BSE, based on the theory of planned behavior (TPB).

Methods This randomized controlled trial was conducted on 240 women aged 30–55 in northern Iran from 2020 to 2022. Participants were selected using a random sampling method and were randomly assigned to three groups of 80 each (face to face, virtual, and control). The face to face educational intervention consisted of four consecutive weekly sessions (50 min each), with 20 participants per session. In the virtual training group, all teaching materials were delivered once a week via WhatsApp messenger. The control group did not receive any intervention. All participants completed questionnaires assessing demographic and fertility characteristics, BSE barriers, knowledge, and practice regarding BSE, as well as TPB constructs (attitude, subjective norm, perceived behavioral control, behavioral intention, and behavior) before, one month, and three months after the intervention. Data analysis was performed using SPSS version 23.0. Statistical tests included the chi-square test, t-test, analysis of variance, repeated measures RMANOVA, and Pearson's correlation coefficient. The significance level was set at $P < 0.05$.

Results The study results indicated that the mean BSE and TPB constructs increased in both the face to face and virtual education groups one and three months after the intervention ($P < 0.001$). In the face-to-face group, knowledge one month after the education was correlated with practice at both one and three months post-education ($r = 0.304$, $P = 0.006$, and $r = 0.232$, $P = 0.038$, respectively). Similarly, in the virtual group, knowledge and practice one month after the education was correlated with knowledge and practice three months post-education ($r = 0.814$, $P = 0.001$, and r = 0.722, $P = 0.001$, respectively).

Conclusions The results of this study demonstrated that TPB is an effective theory for promoting BSE. Both face to face and virtual education interventions proved to be successful, with no significant difference between them.

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Background

Breast cancer (BC) is the most prevalent cancer among women and has the second-highest mortality rate worldwide. The annual incidence of BC is rising by 5.9% [1]. Each year, over two million new cases of BC are reported globally, with nearly 627,000 deaths, making up approximately 15% of all female mortality [2]. The average age at breast cancer diagnosis among Iranian patients is 46 years, significantly lower than in other developing countries. Over the past 10 years, there has been an increasing trend in the age at diagnosis [3]. Approximately 8,500 new cases of BC are reported in Iran each year. In Iranian women, the disease occurs at least a decade earlier and in more advanced stages compared to Western countries [4]. Due to lifestyle changes such as increased life expectancy, growing urbanization, smoking and alcohol consumption, obesity, unhealthy diets, infectious agents, low socioeconomic status, and exposure to environmental carcinogens, the prevalence of BC has risen in most developing countries in recent years [5, 6].

Screening plays a crucial role in the early detection of breast cancer and in improving survival rates. The incidence of BC rises sharply between the ages of 40 and 80. However, it is also relatively common among younger women [7, 8]. One-third of all cancers are preventable, and if detected in the early stages, another third can be cured. The recommended screening methods for BC include breast self-examination (BSE), clinical breast examination (CBE), and mammography [8]. The BSE is a screening method for the early detection of BC that is simple, inexpensive, easy, and effective. It can be performed by women at home to help them become familiar with the appearance of their breasts and monitor for any changes in breast tissue [8]. The BSE can also assist in detecting tumors, cysts, and other abnormalities in the breast. It should be performed at least once a month starting from the age of 20 [9, 10], Although some researchers suggest that it should be done starting at the age of 18 [11]. The optimal time to perform it is between the 7th and 10th day of the menstrual cycle [12], For post-menopausal women, it should be done on a specific day of the month [13, 14].

Studies indicate that Iranian women have limited knowledge and practice regarding BSE, making the implementation of educational interventions in this area necessary [14, 15].

The growing presence of virtual media in recent years and its integration into daily life for exchanging a vast amount of information can serve as a valuable educational resource for BSE. Researchers studying the role of virtual space in the health behavior of young people have found a significant correlation between the use of this space and its positive impact on health [16]. Internet-based interventions may offer a more acceptable approach due to their convenience, accessibility, and privacy [17]. Today, the value of health education programs is emphasized by their effectiveness, which depends significantly on the proper application of health education theories and models. The theory of planned behavior (TPB), proposed by Ajzen, plays a key role in this [18], which is one of the most appropriate and comprehensive theories for studying behavior, has been used in many studies, including those focused on teaching healthy behaviors and cancer prevention [19, 20]. The constructs of the TPB include attitude, subjective norms, perceived behavioral control (PBC), behavioral intention, and behavior. According to this theory, attitude toward behavior, subjective norm regarding behavior, and perceived behavioral control are the three key constructs that determine the intention to perform a behavior [18]. Therefore, support and educational interventions can play a crucial role in improving individuals' behavior and self-efficacy [19].

In general, the more positive the attitude and subjective norm, and the greater the perceived control, the stronger the individual's intention to perform the desired behavior [18]. Therefore, intention is the immediate precursor to behavior. As behavioral control is confirmed, it can act as a proxy for actual control and help predict the desired behavior [21]. In several studies, TPB has been effective in promoting breast cancer screening behaviors [19, 20], However, these studies have not been conducted simultaneously with both virtual and face to face educational methods, which is the novelty of our study. Given the rising incidence of BC and the importance of BSE in diagnosing it [22], the proper use of educational models and theories can serve as an effective educational intervention in this area. Given the importance of the topic, this study was conducted to investigate face to face and virtual education to promote BSE based on the TPB among women in northern Iran.
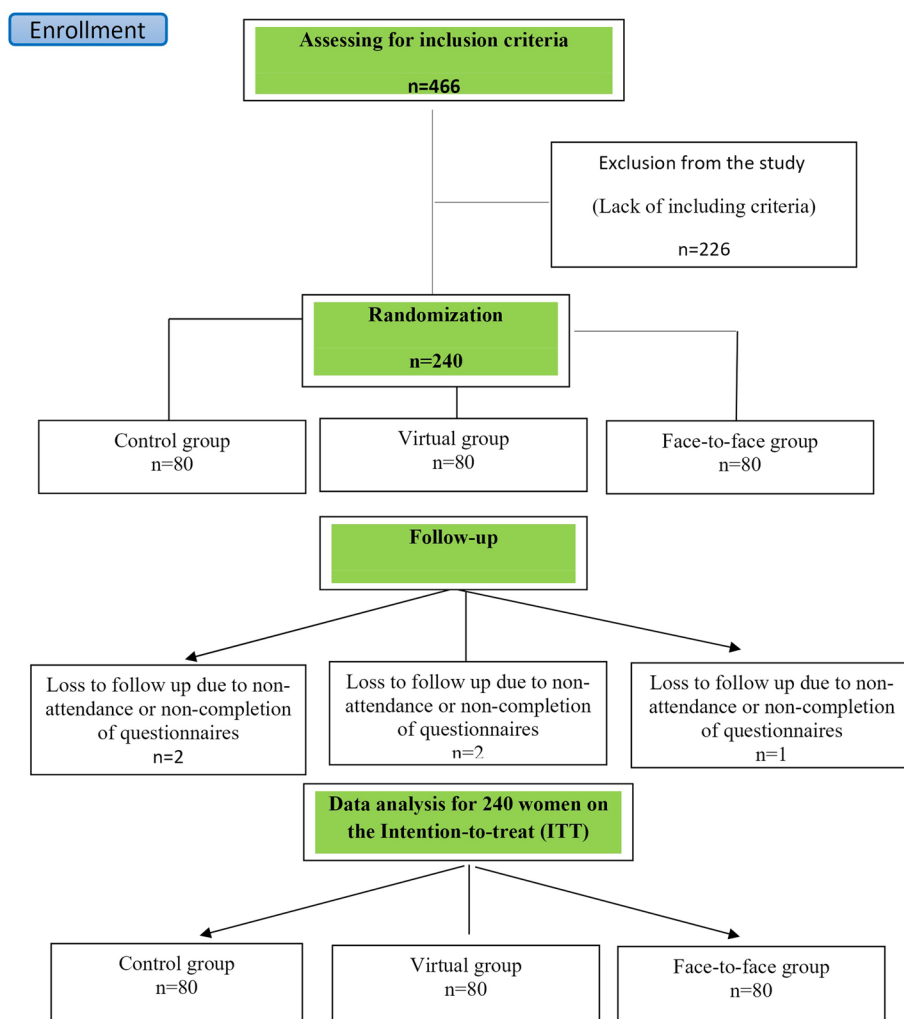
Methods

Study design

This randomized controlled trial was conducted among 240 women aged 30–55 at Babol health care centers in northern Iran between 2020 and 2022. Inclusion criteria

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included poor knowledge and practice of BSE, living in Babol (both urban and rural areas), no history of benign or malignant breast cancer in the participant or her first-degree relatives, no prior health-related education, no pregnancy or breastfeeding at the time of the study, no mental health issues, and willingness to participate in the study. Exclusion criteria included unwillingness to continue training sessions and immigration. A total of 466 eligible women were invited by an electronic system in each health care center to participate in this study, and 226 women were excluded for not meeting the basic criteria. Random allocation was performed using a block design, with the random order based on blocks of six and a 1:1 ratio. As a result, 40 random blocks were created according to the six-block structure. Due to the nature of the study, blinding the researcher or the participant was not feasible, making the study open-label. However, the statistician responsible for analyzing the data was unaware of the coding for the intervention or control groups, so he remained blind, and the study was not entirely open-label. Fig. 1 illustrates the flowchart of study participants at each stage of the protocol. To determine the sample size, the following formula was used along with PASS software version 11 and data from the article by Molatabi et al. [19], With a confidence level of 95%, $\alpha = 0.05$, and a power of 90%, the estimated sample size was 72 people for each of the three study groups. Taking into account a possible dropout rate of 10%, the final sample size was set at 80 people per group. In total, 240 people were included in the study.

$$n = 1 - \Phi \left(\frac{\widehat{\sigma}_{\overline{\beta}_1, H_0}}{\widehat{\sigma}_{\overline{\beta}_1, H_1}} Z_1 - \alpha/2 - \frac{d}{\widehat{\sigma}_{\overline{\beta}_1, H_1}} \right)$$

Fig. 1 Flowchart of participants

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Study setting and recruitment

There are 13 urban–rural health centers in Babol, of which four active health centers (two urban centers and two rural centers) in four geographical areas were selected as clusters, and random sampling was conducted in these four centers. In each health care center, 20 participants were randomly assigned to the face to face group, 20 to the virtual group, and 20 to the control group. Therefore, the study included 120 participants from two urban health care centers and 120 participants from two rural health care centers. The primary outcome was the change in scores on the TPB constructs (attitude, subjective norms, PBC, behavioral intention, and behavior), while the secondary outcome involved changes in scores related to women's knowledge and practice of BSE, including the observation of women performing BSE by the researcher.

Data collection

The data collection tools consisted of questionnaires on demographic and fertility characteristics, BSE barriers, knowledge and practice regarding BSE, and BSE questionnaires based on the TPB. The demographic fertility questionnaire included information on age, education level, occupation, spouse's education, spouse's occupation, residence, income satisfaction, age at menarche, age at marriage, marriage duration, number of pregnancies, and number of children.

The BSE barriers questionnaire consisted of seven questions related to forgetfulness, lack of time, lack of knowledge, lack of education, fear of biopsy, fear of touching the mass, and fear of pain. The responses to these questions were in a two-choice format: yes or no.

The knowledge questionnaire and the practice assessment checklist were researcher-designed questionnaires. The knowledge questionnaire consisted of 40 questions on the signs and symptoms of BC, associated risk factors, and methods of early cancer detection. Each answer was scored as follows: two points for a correct answer, one point for "I don't know," and zero points for a wrong answer. Participants' knowledge was categorized into three groups based on their score: good (54–80), average (27–53), and poor (0–26).

The checklist for observing women's practice on BSE consisted of 14 items, which were observed and marked by the researcher. If a woman performed each item correctly, it was given a score of one; if performed incorrectly, it was given a score of zero. The practice level, based on the score, was divided into three categories: poor (0–4), average (5–9), and good (10–14). The questionnaires on knowledge and practice were evaluated for content validity and face validity. Additionally, 10 questionnaires were given to 10 professors and experts in midwifery and health education for feedback on their validity. The questionnaires were then revised based on their corrective and complementary comments. In the content validity assessment, the content validity index (CVI) for the knowledge and practice questions was 0.84 and 0.87, respectively, indicating good content validity [23]. The content validity ratio (CVR) for the knowledge and practice questions was also 0.77 and 0.79, respectively, indicating good content validity [23]. Test–retest reliability analysis was used to determine the reliability of the questionnaires. In this way, the same questionnaires were given to 30 participants under the same conditions as the main study samples. After 10 days, the same 30 participants were given the same questionnaires. Then the correlation coefficient between test and retest was calculated, which was 0.85 for knowledge questions and 0.84 for practice questions.

We used the BSE questionnaire based on the TPB, which was designed by Matlabi and colleagues. In the study by Matlabi et al., the internal consistency of the different constructs ranged from 0.97 to 0.99, and the validity ranged from 0.95 to 0.98 [19]. The BSE questionnaire based on the TPB consists of 31 questions, covering the following constructs: attitude (8 questions), subjective norm (7 questions), perceived behavioral control (8 questions), behavioral intention (4 questions), and behavior (4 questions). For the questions on attitude, subjective norms, PBC, and behavioral intention, a five-point Likert scale was used, with the following responses: "strongly agree," "agree," "no comments," "disagree," and "strongly disagree." The questions on behavior were rated on a five-point Likert scale (always, most of the time, sometimes, rarely, and never), with scores ranging from 1 to 5, respectively, from minimum to maximum. The score range for each construct was as follows: attitude (1–40), subjective norm (1–35), perceived behavioral control (1–40), behavioral intention (1–20), and behavior (1–8). The total score ranged from 1 to 143. A higher score and total score indicate that the person is in a better condition within each construct [19].

Before the education sessions, the researcher explained the project objectives, the follow-up process one and three months after the sessions, and how to complete the questionnaires for all three groups. Participants were informed about the date and time of the information events. After obtaining informed consent, the questionnaires were completed by the participants in the presence of the researcher. The scores from the questionnaires were then calculated. Women with poor knowledge and practice (240 participants) were included in the study, while those with average and good practice were excluded. For the face-to-face education group, four consecutive 50-min weekly sessions

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were held, consisting of three theory sessions and one practical training session. The researcher organized the classes in a training room at each health care center and conducted the sessions. The lessons were held separately for each group. The teaching content was the same across all groups, following the TPB structure. In the face-to-face training sessions, various methods were used, including lectures, question and answer sessions, slide shows, educational films, brochures, and training participants with moulage. At the end of the fourth session, the training booklet was provided to the participants in the intervention group. After the sessions, participants in the face to face intervention group were reminded that if they had any questions regarding the training, they could receive correct answers via SMS. In the virtual intervention group, the same educational content as in the face-to-face intervention sessions was delivered using speech (in five 10-min sessions), slides, and educational videos sent via WhatsApp. No educational intervention took place in the control group, and they were placed on a waiting list. At the end of the study, the content from all face-to-face and online training sessions was provided to the control group participants at their request, to meet the ethical requirements of the research. All participants in the three groups completed the BSE and knowledge questionnaires in the presence of the researcher before the study, and one and three months after the completion of the face-to-face sessions. Additionally, their practice was evaluated, and the practice questionnaire was filled out by the researcher. The content of the training is presented in Table 1.

Data analysis

The data were analyzed using SPSS version 23.0. Descriptive statistics were presented with the mean and standard deviation or relative and absolute frequency. Analytical statistics were performed using the chi-square test, t-test, analysis of variance, repeated measures ANOVA (RMANOVA), and Pearson's correlation coefficient. Intention-to-treat (ITT) analysis was used for data management, and no participants were excluded from the study. The significance level of the tests was set at $P < 0.05$.

Results

The demographic and fertility-related characteristics in the face-to-face, virtual, and control groups are presented in Table 2. Most of the women had an education level below a diploma, and no significant differences were found in any of the variables across the three groups (Table 2).

The mean score of TPB constructs before the intervention showed no significant difference between the three groups. However, after one and three months of training, the mean score of all constructs in the face-to-face and virtual groups showed a significant difference compared to the control group ($P = 0.001$). Therefore, the educational intervention based on the TPB improved all constructs in the face-to-face and virtual groups (Table 3).

The mean score of knowledge showed no significant difference between the three groups. However, after the training, the rate of knowledge increased over time in both the face-to-face and virtual groups ($P = 0.001$) (Fig. 2). The mean practice score at the before intervention showed no difference between the three groups. However, after intervention, mean practice improved over time in both the face-to-face and virtual groups ($P = 0.001$) (Fig. 3).

Lack of education and fear of touching the mass were the main barriers to BSE, with no significant difference between the groups before the intervention. However, a significant difference was observed after one and three months of intervention ($P = 0.001$) (Table 4).

Based on Pearson's correlation coefficient, the practice in the face-to-face group was significantly correlated with the spouse's education one month after the

Table 1 Training programs implemented in the intervention groups

Training sessions	Description of the training sessions
Session 1	Based on the structure of attitude and importance of BSE, signs and symptoms of BC, complications, prevalence and mortality rates, benefits of BSE screening, and participation in screening programs.
Session 2	Based on subjective norms, explanations were given about BSE in communication with close friends, parents, sister, wife, husband's family, and important people in the community. In addition to the importance of pregnancy and breastfeeding, and a healthy lifestyle in preventing BC.
Session 3	Based on the PBC construct, explanations were provided regarding a person's feelings about voluntary control to perform or not perform a behavior, facilitators, and barriers to BSE behavior, normal breast anatomy, the difference between normal and abnormal breast masses, and various BC diagnostic procedures.
Session 4	Explanations were given based on the behavioral intention and behavior, focusing on the intensity of the individual's intention to perform the behavior, different BSE methods, the appropriate monthly time to perform BSE, and the time required to do so. Practical training with moulage was also conducted, and an educational video on how to perform SBE was displayed.

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Table 2 Demographic and fertility characteristics in face to face, virtual, and control groups (*n* = 240)

Groups Variables	Face-to-face *n* = 80	Virtual *n* = 80	Control *n* = 80	*P*-value[†]
[a]Age (year)	42.95 ± 6.34	42.15 ± 5.14	42.68 ± 7.4	0.772
[a]Menarche age	12.45 ± 0.72	12.4 ± 0.77	12.41 ± 0.74	0.908
[a]Marriage age (year)	19.63 ± 4.63	19.71 ± 4.76	19.4 ± 5.39	0.918
[a]Marriage duration (year)	23.34 ± 7.43	22.89 ± 6.68	23.4 ± 9.11	0.903
[a]Number of pregnancy	2.43 ± 1.05	2.24 ± 0.76	2.41 ± 1.11	0.408
[a]Number of children	2.06 ± 0.75	2.01 ± 0.49	2.03 ± 0.79	0.893
[b]**Education level**				*P*-value[††]
Primary school	45 (56.3)	44 (55)	46 (57.5)	0.998
High school diploma	24 (30)	24 (30)	23 (28.8)	
University degree	11 (13.8)	12 (15)	11 (13.8)	
[b]**Occupation**				0.851
Housekeeper	73 (91.3)	72 (90)	73 (91.3)	
Employed	7 (8.8)	8 (10)	7 (8.8)	
[b]**Spouse's education level**				0.994
Primary school	52 (65)	51 (63.8)	52 (65)	
High school diploma	18 (22.5)	17 (21.3)	17 (21.3)	
Academic degree	10 (12.5)	12 (15)	11 (13.8)	
[b]**Spouse's occupation**				0.988
Employed	8 (10)	7 (8.8)	7 (8.8)	
Free	68 (85)	70 (87.5)	70 (87.5)	
Unemployed	4 (5)	3 (3.8)	3 (3.8)	
[b]**Satisfied with income**				0.998
Satisfied	20 (25)	19 (23.8)	19 (23.8)	
Relatively satisfied	47 (58.8)	48 (60)	49 (61)	
Dissatisfied	13 (16.3)	13 (16.3)	12 (15)	
[c]**Residence**				
City	40 (50)	40 (50)	40 (50)	1.000
Village	40 (50)	40 (50)	40 (50)	

[†] The data were assessed using ANOVA test

[††] The data were assessed using chi-square test

[a] Data expressed as mean ± SD

[b] Data expressed as number (%)

intervention. Women whose spouses had less than a high school diploma performed better (*P* = 0.026). In the virtual group, there was a positive correlation between the women's practice and their place of residence, with women living in the city performing better (*P* = 0.046). In the virtual education group, knowledge and practice one month after the intervention were related to knowledge and practice three months after the education (*r* = 0.814, *P* = 0.001, and *r* = 0.722, *P* = 0.001, respectively). In the control group, the scores on all TPB constructs were lower than the other two groups, and there was a high correlation coefficient between knowledge and practice before the intervention and at the two time periods after the intervention. Based on Pearson's correlation coefficient, in the face-to-face education group, the women's

knowledge one month after the intervention was significantly correlated with knowledge and practice three months after the intervention (*r* = 0.801, *P* = 0.001, and *r* = 0.232, *P* = 0.038, respectively). Additionally, the women's practice one month after the intervention was significantly correlated with their practice three months after the intervention (*r* = 0.864, *P* = 0.001). The relationship between knowledge and practice before and after the intervention in the face-to-face intervention group is shown in Table 5.

Discussion

This study aimed to evaluate the effectiveness of face to face and virtual training based on the TPB on BSE. The results, consistent with the primary outcome,

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Table 3 Mean scores of TPB constructs before and after the intervention in all three groups (*n* = 240)

Groups Variables	Face to face mean ± SD	Virtual mean ± SD	Control mean ± SD	*P*-value[†]
Attitude				
Before the intervention	2.32 ± 16.56	1.34 ± 16.55	0.81 ± 16.81	0.513
One month after the intervention	1.87 ± 38.48	1.63 ± 38.16	0.7 ± 17.04	0.001
Three months after the intervention	0.63 ± 39.59	0.76 ± 39.53	0.7 ± 17.06	0.001
Subjective norm				
Before intervention	12.91 ± 1.29	13.06 ± 1.28	13.1 ± 1.14	0.601
One month after the intervention	33.32 ± 1.12	33.91 ± 0.91	13.28 ± 1.01	0.001
Three months after the intervention	34.14 ± 0.77	33.95 ± 1.03	13.34 ± 1.04	0.001
[a]**PBC**				
Before the intervention	14.35 ± 2.3	14.3 ± 2.29	14.3 ± 2.28	0.987
One month after the intervention	38.76 ± 1.27	39.21 ± 0.82	14.31 ± 2.25	0.001
Three months after the intervention	39.68 ± 0.61	39.72 ± 0.57	14.3 ± 2.29	0.001
Behavioral intention				
Before the intervention	5.93 ± 0.76	5.87 ± 0.62	5.82 ± 0.86	0.645
One month after the intervention	18.93 ± 1.33	19.93 ± 1.24	5.91 ± 0.55	0.001
Three months after the intervention	19.62 ± 0.6	19.66 ± 0.47	5.91 ± 1.08	0.001
Behavior				
Before the intervention	4.06 ± 0.33	4.09 ± 0.32	4.06 ± 0.29	0.847
One month after the intervention	6.68 ± 0.75	6.71 ± 0.95	4.13 ± 0.4	0.001
Three months after the intervention	7.84 ± 0.4	7.93 ± 0.47	4.16 ± 0.48	0.001

[a] *PBC* Perceived behavioral control

[†] The data were assessed using ANOVA repeated measure
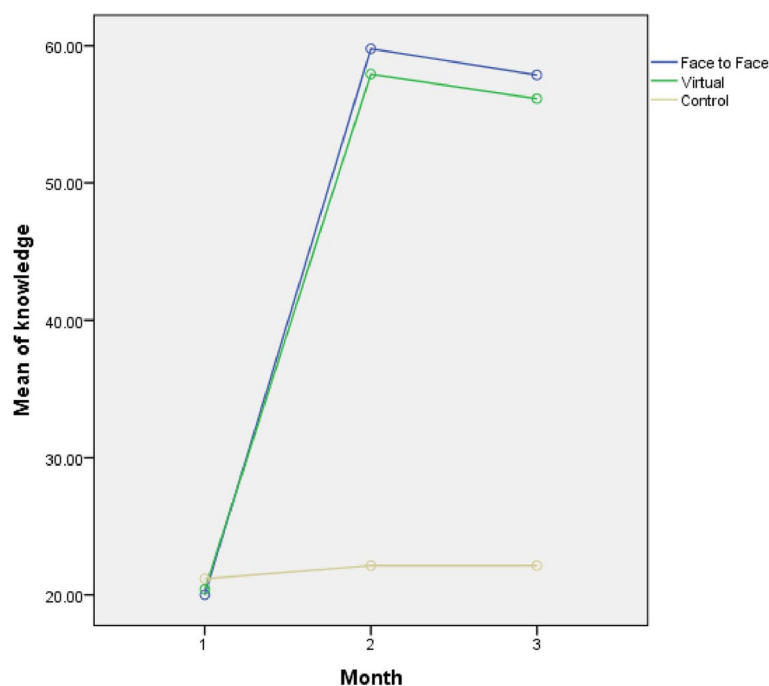
Fig. 2 Comparison of changes in the women's knowledge score before the intervention, one month, and three months after the intervention in all three groups

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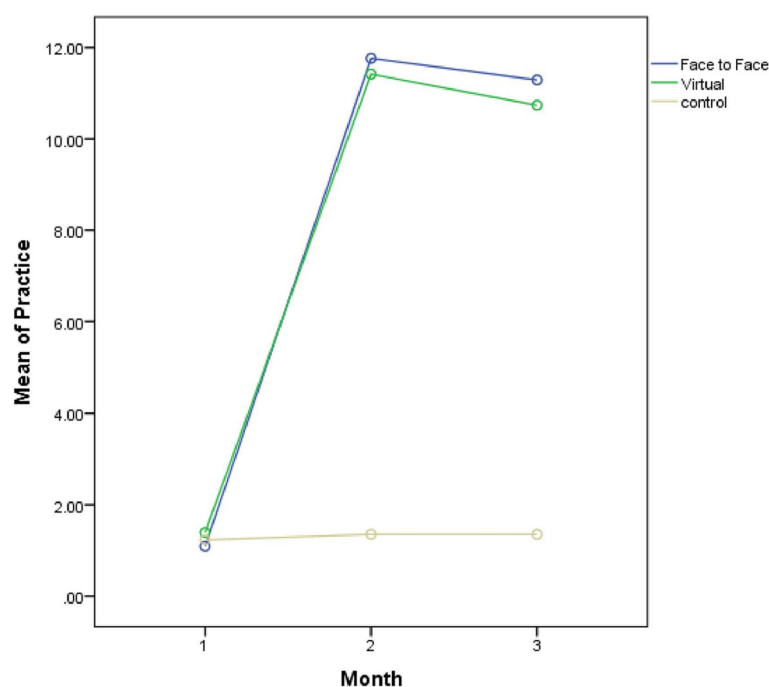
Fig. 3 Comparison of the changes in the women's practice values before the intervention, one month, and three months after the intervention in all three groups

demonstrated that both face to face and virtual training significantly increased the scores of all constructs in the TPB model one and three months after the intervention compared to before. A study by Matlabi et al. found that group training, consisting of four theoretical sessions and one practical session based on TPB scales, led to a significant increase in the mean scores of all constructs in the intervention group, with the educational effects lasting three months. Additionally, the positive change in BSE behavior was more pronounced than in other constructs of the theory [19]. The results of a study based on the Theory of Planned Behavior TPB indicated that subjective norms, behavioral attitudes, and PBC had a significant relationship with intentions to engage in breast cancer screening [24]. Additionally, in another study, researchers found that BSE increased significantly with a positive attitude and strong subjective norms [22]. The results of Bashirian et al.'s study indicated that protective motivation and social support had similar effects on BSE performance. However, the e-learning program was documented in a video interview [25]. Kissal et al.'s study showed that training based on the Health Belief Model (HBM) had no statistically significant effect on health beliefs and BSE. However, knowledge of BC and BSE skills increased after the training [26]. The results obtained align with the findings of the present study, highlighting the effectiveness of educational interventions. A study has shown that HBM-based training

positively contributes to women's knowledge, attitudes, and health behavior regarding BSE. Therefore, implementing an HBM-based training program along with regular follow-up could lead to consistent and proper BSE practices [27]. In Kamyab et al.'s study, similar results were observed as in our study, with TPB-based education playing a significant role in enhancing awareness, attitude, PBC, subjective norms, and behavioral intention toward BC screening [28]. The above studies differ from our study in terms of methods, number of sessions, and participants. Although, the teaching is based on a model or theory that indicates the effectiveness of education and is consistent with the results of the present study.

The results of our study, in line with the secondary outcomes that included knowledge and practice of BSE, showed that both face-to-face and virtual training had a significant effect on increasing the scores of knowledge and practice in one and three months after the training compared to before. These findings align with those of Abolfotouh et al., who found that Saudi women had negative attitudes and insufficient knowledge about BSE, resulting in very infrequent SBE performance. However, working women and those with a family history of BC had more knowledge and fewer perceived barriers to BC, leading to more frequent performance of BSE. Additionally, they concluded that the HBM theory was a valid tool for predicting BSE performance in Saudi women [29]. Tesfaw et al. stated that the knowledge and performance

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Table 4 Barriers to breast self-examination in the face to face, virtual, and control groups (*n* = 240)

Groups Variables	Face to face N (%)	Virtual N (%)	Control N (%)	*P*-value[†]
Forgetfulness				
Before the intervention	74 (92.5)	73 (91.3)	72 (90)	0.855
One month after the intervention	6 (7.5)	4 (5)	71 (88.8)	0.001
Three months after the intervention	3 (3.38)	2 (2.5)	69 (86.3)	0.001
Lack of time				
Before the intervention	72 (90)	73 (91)	71 (88.8)	0.870
One month the intervention	2 (2.5)	4 (5)	70 (87.5)	0.001
Three months after the intervention	2 (2.5)	0	69 (86.3)	0.001
Lack of knowledge				
Before the intervention	76 (95)	76 (95)	77 (96.3)	0.707
One month after the intervention	6 (7.5)	8 (10)	78 (97.5)	0.001
Three months after the intervention	1 (1.3)	3 (3.8)	76 (95)	0.001
Lack of education				
Before the intervention	77 (96.3)	78 (97.5)	77 (96.3)	0.815
One month after the intervention	7 (8.8)	8 (10)	76 (95)	0.001
Three months after the intervention	2 (2.5)	3 (3.8)	75 (93.8)	0.001
Fear of biopsy				
Before the intervention	31 (38.8)	30 (37.5)	33 (41.3)	0.909
One month after the intervention	3 (3.8)	2 (2.5)	32 (40)	0.001
Three months after the intervention	1 (1.3)	2 (2.5)	34 (42.5)	0.001
Fear of touching the mass				
Before the intervention	77 (96.3)	78 (97.5)	77 (96.3)	0.897
One month after the intervention	7 (8.8)	8 (10)	76 (95)	0.001
Three months after the intervention	2 (2.5)	3 (3.8)	75 (93.8)	0.001
Fear of pain				
Before the intervention	31 (38.8)	30 (37.5)	33 (41.3)	0.855
One month after the intervention	3 (3.8)	2 (2.5)	32 (40)	0.001
Three months after the intervention	1 (1.3)	2 (2.5)	34 (42.5)	0.001

[†] The data were assessed using ANOVA repeated measure

of breast cancer early screening methods among female health workers were low, with less than half of them performing regular BSE. This highlights the need for training healthcare providers to promote the early detection of breast cancer [30]. The results of the study by Ranganath et al., which was a pre- and post-training study, showed significant improvements in the post-test. The students' scores for knowledge, attitude, and skills increased after the intervention. Additionally, the mean scores for self-examination performance skills were higher after lectures combined with exercises than after lectures alone [31]. In the study by Rakhshani et al., similar results were observed as in our study, where the educational intervention played a significant role in increasing women's

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Table 5 The correlation between the women's knowledge and their practice in the face to face group, before, one month, and three months after the intervention (*n* = 240)

Variable	Knowledge before the intervention	Practice before the intervention	Knowledge one month after the intervention	Practice one month after the intervention	Knowledge three months after the intervention	Practice three months after the intervention
Knowledge before the intervention						
Practice before the intervention	$r = -0.093$ $P = 0.413$					
Knowledge one month after the intervention	$r = -0.002$ $P = 0.413$	$r = -0.073$ $P = 0.521$				
Practice one month after the intervention	$r = 0.067$ $P = 0.553$	$r = 0.070$ $P = 0.535$	$r = 0.304$ $P = 0.006$			
Knowledge three months after the intervention	$r = -0.023$ $P = 0.836$	$r = 0.065$ $P = 0.565$	$r = 0.801$ $P = 0.001$	$r = 0.420$ $P = 0.001$		
Practice three months after the intervention	$r = -0.018$ $P = 0.837$	$r = 0.056$ $P = 0.619$	$r = 0.232$ $P = 0.038$	$r = 0.864$ $P = 0.001$	$r = 0.349$ $P = 0.002$	

knowledge, attitude, and practice toward breast cancer screening [32]. The difference between this study and our study is that they did not use a training model. In another study investigating BSE and its influencing factors based on the theory of planned behavior, the results indicated that the mean scores of awareness significantly differed between two groups of women: those with a history of self-examination and those without. The researchers suggested that educational interventions based on the theory of planned behavior are valuable for improving awareness and assisting women in the timely diagnosis and treatment of breast cancer [14]. Therefore, although sufficient knowledge in the field of health issues is a necessary condition for people's behavior, there is not always a direct relationship between knowledge and practice. People who possess more knowledge do not necessarily exhibit higher health behaviors. Other influencing factors, such as attitude, subjective norm, PBC, and behavioral intention, also play crucial roles as predictors of behavior. By promoting these TPB constructs, we can encourage the desired behavior.

The results of our study showed that in the face to face education group, there was a strong relationship between women's practice and their knowledge after the intervention. In this group, a significant connection was also observed between women's practice and their spouse's education after the intervention. Additionally, in the virtual training group, a positive correlation

was found between women's practice and their place of residence, as well as their knowledge after the intervention. Similarly, Lera et al. showed that women's BSE practice was relatively low, and that factors such as BSE knowledge, 24-month breastfeeding, being a student, and having a job were important influences on BSE. Educating women, especially through electronic media, has been shown to effectively improve BSE practice by increasing awareness [33]. Terfa et al. reported that age, occupation, family history of breast cancer, and monthly income were significantly associated with BSE performance [34]. A systematic review by Yeshitila revealed that informal education, a family history of breast cancer, good knowledge, and a positive attitude toward BSE were significantly associated with BSE practice. Additionally, only one-third of women of childbearing age had undergone a breast examination, highlighting the need for intervention programs to promote BSE [35]. Thus, public education for illiterate women could help reduce the number of advanced-stage BC cases in low-income countries. Although the above studies differ in methods, session numbers, and participants, they consistently indicate the effectiveness of training, aligning with our study's findings. Therefore, educational intervention based on the TPB is an effective method for BC screening.

Our results show that lack of education and fear of touching the masses were the main barriers to SBE. While there

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was no significant difference between the groups before the training, this difference became significant after the intervention. A study in southern Ethiopia revealed that a lack of knowledge on how to perform BSE and forgetfulness to practice regularly were the main reasons for not performing BSE. Therefore, addressing communication barriers, promoting behavioral changes, and enhancing skills for BSE should be key focus areas. Additionally, applying educational theories could be one of the most effective strategies in health and education [36]. The effectiveness of BSE in reducing mortality remains a challenge, and several international organizations no longer recommend it as a screening method. However, in developing countries, where women are often diagnosed with breast cancer at a younger age, BSE may contribute to early detection of BC [37]. The age of breast cancer in Iran is lower than in developed countries, estimated to be between 35 and 45 years old [14]. BSE, as a non-specific preliminary screening test, can play an important role in the early possible diagnosis of breast cancer, serving as a prelude to subsequent specific tests. Therefore, it may help reduce morbidity and mortality caused by breast cancer. In developing countries, women's awareness of this examination is low, and performing BSE in these societies based on educational models is valuable.

The strength of our study was the simultaneous education in face-to-face and virtual methods based on TPB to improve knowledge, practice, and theoretical structures of BSE, which may contribute to the rapid recognition of breast cancer. Therefore, both virtual and face-to-face education represent strong points. Moreover, this study examined women aged 30–55 years through random sampling from urban and rural health centers, which was not the case in previous studies. This approach is affordable, simple, and accessible to women without complications. One potential limitation of the study was that it was conducted in a single region. Therefore, it is recommended that similar studies using this theory be conducted in a multicenter setting across different cities and provinces. Additionally, since the TPB questionnaires were completed through self-reports, there were limitations in the reliability of responses. However, efforts were made to ensure clarity in the questions, and the researcher was available to assist participants during questionnaire completion. Due to time constraints, the follow-up period was relatively short, whereas a longer study duration could provide better insights into the long-term stability of BSE behavior among participants.

Conclusion

In conclusion, this study found that the educational intervention based on the TPB theory was effective in improving both BSE knowledge and practice. The intervention had the most significant impact on the PBC construct, while the least effect was observed on the attitude construct, suggesting the need for further educational efforts to enhance women's attitudes toward BSE. Despite the positive outcomes, there remains a gap in attitude and knowledge regarding BSE among women in Iranian society. The training should particularly focus on individuals with poorer attitudes, practices, and knowledge. Educational interventions in women's health management can play a key role in improving early breast cancer detection. The primary motivation for this research was to enhance knowledge, practices, and reduce barriers. Given that the findings showed BSE training based on TPB is effective, it is recommended that this model be utilized for designing and implementing screening interventions, ensuring continuity, and fostering behavior change in various aspects of women's health.

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