## RESEARCH





# The effect of educational intervention based on protection motivation theory in improving reproductive health protective behaviors: a quasi-experimental study

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## Abstract

**Background** Reproductive health has broad implications for individuals, families, and society. This study aims to explore how an educational intervention, centered around PMT, can enhance reproductive health protective behaviors among female students.

**Methods** This quasi-experimental study was conducted on female students of Khomein University of Medical Sciences in Markazi Province, Iran, from December 2023 to August 2024. A random cluster sampling method was used for sampling, resulting in 51 female students being selected for the intervention group and 54 female students for the control group. The data collection tool was a researcher-developed questionnaire, which included demographic information and PMT constructs with confirmed validity and reliability.

The educational intervention for the intervention group consisted of three one-hour sessions spaced one week apart, incorporating methods such as lectures, group discussions, Q&A sessions, brainstorming, role-playing exercises, as well as distribution of educational booklets. The collected data was then analyzed using various statistical methods including independent t-tests, t-tests, chi-square tests, simple linear regression, and multiple linear regression models.

**Results** After the intervention, the mean score for all constructs in the intervention group was higher than that of the control group, except for perceived cost. A statistically significant difference was noted in the mean scores of most constructs, such as perceived susceptibility, perceived severity, perceived self-efficacy, protection motivation, fear, and behavior, between the two groups being studied (p < 0.05).

**Conclusion** The PMT-based educational intervention has proven to be effective in promoting reproductive health protective behaviors among female students. Given the significance of infertility issues and the value of preserving fertility in young women, it is recommended to implement PMT-based educational programs to safeguard women's reproductive health.

Keywords Education, Reproductive health, Female, Behavior, Protection motivation theory

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## Introduction

Reproductive health has broad implications for individuals, families, and society [1]. The prevalence of infertility among women is on the rise globally, with estimates suggesting that approximately 72.4 million women are affected [2, 3]. Infertility can lead to significant psychosocial challenges [4]. It is recognized as a major global public health issue, ranking as the fifth most significant global disability and having a detrimental effect on the self-esteem of individuals affected. Infertility tends to have a greater negative impact on women in terms of side effects and social burden when compared to men [5, 6]. Changes in environment and lifestyle, as well as postponement of marriage and the birth of a first child, alongside environmental pollution and unhealthy habits, have been linked to a rise in infertility cases [7, 8]. Certain infections, including Escherichia coli, Staphylococcus aureus, gonorrhea, parasitic infections, tuberculosis, and sexually transmitted diseases [9, 10], as well as conditions like diabetes, hypertension, hypothyroidism, endometriosis, polycystic ovary syndrome, and lifestyle factors such as obesity, substance abuse, smoking, alcohol consumption, and stress, are among the factors contributing to infertility [11, 12]. Many studies have offered evidence regarding the relationship between lifestyle behaviors, such as delaying childbearing to pursue work or education, the age at which families are formed, alcohol and caffeine consumption, cell phone usage and exposure to radiation, smoking, high-fat diet, lack of physical activity, risky sexual behaviors, and drug abuse [13–19].

Knowledge of human fertility is essential for young female students as a demographic group [20]. During adolescence, significant behavioral patterns, such as those pertaining to fertility, are established. Many young individuals transition into adulthood without adequate preparation. Research indicates that Iranian youth possess minimal understanding of reproductive health [21]. On the other hand, students lack adequate knowledge about the preventable causes of infertility, as well as essential concepts like the female reproductive window and the age at which reproductive ability declines. They are also unaware of preventable factors that can contribute to infertility [22].

An important benefit of educating students about fertility, infertility, and how age and other factors affect fertility is that they will be able to make their own decisions about marriage, pregnancy, and childbearing. Gaining fertility knowledge is essential because of the role of risk factors such as preconception health, being overweight or underweight, alcohol and drug use, and infectious diseases on fertility [23]. Therefore, educating students about infertility and its risk factors is a necessity for its prevention and reduction [22]. The Protection Motivation Theory (PMT) is the most effective theory for promoting health and predicting preventive behaviors [24]. As per the PMT, individual and environmental factors may either promote or hinder engagement in protective behaviors [25]. This theory includes the constructs of perceived susceptibility, perceived severity, perceived rewards, perceived cost, perceived self-efficacy, response efficiency, fear and protection motivation [26, 27].

Kashefi's study aimed to investigate attitudes towards reproductive health and its influencing factors among Iranian university students. The findings indicated that the students' attitudes towards reproductive health are not at a satisfactory level. [21]. Öztürk's research in Turkey aimed to assess the impact of an infertility prevention psychoeducation program on students' understanding and perceptions of infertility. The findings revealed that the psychoeducation program significantly improved participants' knowledge and attitudes towards infertility. In studies exploring sex and fertility education initiatives for students, infertility has frequently been overlooked as a subject for educational purposes [28]. Since there is a noticeable gap in research focusing on educating young girls about risk factors and methods to improving reproductive health protective behaviors through health education and health promotion models, this study was carried out to assess the impact of an educational intervention based on PMT in improving reproductive health protective behaviors in female students.

## Hypothesis

The mean score of PTM constructs and reproductive health protective behaviors in the intervention group will increase after the educational intervention to reproductive health protective behaviors in female students compared to the control group.

## Method

## Study design

This quasi-experimental study was conducted on female students of Khomein University of Medical Sciences, Markazi Province, located in the center of Iran from December 2023 to August 2024.

## Participants

According to the study of Öztürk B et al. [28], the sample size of the study was 96 people according to the formula, including 48 people for the intervention group and 48 people for the control group.

$$n = \frac{z^2 \bullet p(1-p)}{d^2} = \frac{(1.96)^2 * 0.8(1-0.8)}{(0.08)^2} = \frac{0.6144}{0.0064} = 96$$

To conduct sampling, a random cluster sampling method was employed, with each field of nursing, operating room, anesthesiology, medical laboratory sciences, and public health treated as a cluster. Subsequently, one class from the intervention group and one class from the control group were randomly chosen from each cluster. In each class, individuals who met the inclusion criteria were selected for the study. Consequently, 51 female students were chosen for the intervention group, and 54 females for the control group. However, due to sample loss, data from 49 participants in the intervention group and 50 participants in the control group were analyzed.

To minimize the risk of knowledge contamination between the control group and the intervention group following the educational intervention, individuals from each group were chosen from separate classes. Furthermore, as students from varying educational levels and majors occupy distinct suites within the university dormitory, the likelihood of information exchange within the dormitory is minimal.

The inclusion criteria consisted of single female students at Khomein University of Medical Sciences who had no plans to take academic leave or transfer to another university in the upcoming semester (until the study was completed) and who had signed a written consent form to participate in the study. The exclusion criteria included individuals in the intervention group who missed more than one session of the educational intervention classes, as well as those who did not fully complete the questionnaires before or after the intervention or completed them incompletely.

It is important to acknowledge that married students were not included in the study due to the nature of certain questions in the questionnaire, such as those relating to intentions to marry in the future, fears about future marriage, preparations for future marriage, and discussions with peers about marriage. Additionally, there may be variations in knowledge and attitudes towards fertility between single and married individuals.

## Instrument and data collection

The data collection tool was a researcher-made questionnaire that included demographic information (age, father's occupation, mother's occupation, father's education, mother's education, family income, physical activity) and PMT constructs. In order to design the PMT questionnaire, the constructs were identified by regular review of scientific literature and using experts' opinions. Then the design of the questions of each construct was done and the necessary corrections were made in the writing and ordering of the questions and appropriate scoring. To determine the content validity, first, 10 health education experts and reproductive health experts were asked to review the questionnaire based on the use of appropriate words, appropriateness of questions and selected dimensions, placement of items in the appropriate place, and appropriate scoring. As a result, 12 questions were corrected and 5 questions were deleted. Then, Content Validity Ratio (CVR) and Content Validity Index (CVI) were measured. To determine CVR, 10 reproductive health and health education experts were asked to score each of the questions in terms of its content in three ways: necessary, useful or unnecessary. According to Lawshe's Table [29], CVR values higher than 0.62 were accepted. The CVR was calculated as 0.89. CVI values with three criteria of relevance, simplicity, and clarity were determined by using a four-part Likert scale for each item by the same experts. The minimum acceptable CVI is 0.79 [30].

In order to measure the reliability, the questionnaire was completed by 20 female students of Khomein University of Medical Sciences who were randomly selected. These people did not participate in the next stages of the study. The obtained information was used to calculate the Cronbach's alpha of the questionnaire. Cronbach's alpha was calculated for perceived susceptibility 0.89, perceived severity 0.78, perceived rewards 0.82, perceived cost 0.81, perceived self-efficacy 0.92, response efficiency 0.89 and the questionnaire as a whole was 0.84.

This questionnaire consisted of a total of 48 questions. The perceived susceptibility construct had 8 questions with a minimum score of 8 and a maximum score of 40 on a five-point Likert scale. Questions such as: I am likely to suffer from infertility; Marrying at an older age increases my risk of infertility; Ignoring personal and sexual hygiene can cause infertility. The perceived severity construct had 4 questions with a minimum score of 4 and a maximum score of 20 on a five-point Likert scale. Questions such as: Infertility is a serious problem in every woman's life; infertility treatment is very difficult and expensive. The perceived rewards construct had 4 questions with a minimum score of 4 and a maximum score of 20 on a five-point Likert scale (reverse scoring compared to other constructs). Questions such as: Fast foods (e.g., pizza, sausage, etc.) and sweets are very tasty; Smoking and alcohol consumption can create pleasure and relaxation. The perceived self-efficacy construct had 7 questions with a minimum score of 7 and a maximum score of 35 on a five-point Likert scale. Questions such as: I can maintain my weight at a balanced level; I can devote 30 min of my time to exercise daily; I have the ability to get married at a young age. The response efficiency construct had 5 questions with a minimum score of 5 and a maximum score of 25 on a five-point Likert scale. Questions such as: If I reduce my consumption of fast foods

(such as pizza, sausage, hot dogs, etc.) and sweets, I can keep my weight in an ideal state; If I reduce my consumption of caffeine (tea and coffee), my risk of infertility will decrease. The perceived cost construct had 8 questions with a minimum score of 8 and a maximum score of 40 on a five-point Likert scale (reverse scoring compared to other constructs). Questions such as: Preparing and consuming a healthy and nutritious diet is time-consuming and difficult; There is not enough suitable environment for women to exercise in the city; I do not have enough information to observe personal and sexual hygiene. The protection motivation construct had 7 questions with a minimum score of 7 and a maximum score of 35 on a five-point Likert scale. Questions such as: I intend to maintain my weight at a balanced level; I intend to permanently avoid smoking and alcohol; I intend to increase my knowledge about the factors affecting infertility by studying more in the future. The fear construct had 5 questions with a minimum score of 5 and a maximum score of 25 on a 5-point Likert scale. Questions such as: The increase in the number of infertile couples in society has worried me; I am afraid of being an infertile person in the future. Behavioral questions were designed in the form of 8 questions with 4 answers: "always, sometimes, rarely, and never". Questions such as: On average, I exercise for 30 min a day; I observe personal and sexual hygiene; I exchange opinions with people around me about marriage and having children.

## Intervention program

After holding a briefing session about the objectives of the research and ensuring the confidentiality of the information, the written consent form was completed by the participants. Then, the demographic information questionnaire and researcher-made questionnaire based on the PMT constructs and infertility prevention behaviors were completed by the intervention and control groups. The educational intervention program was developed utilizing the PMT constructs based on the data analysis results from the questionnaires. Reliable scientific sources were consulted to create relevant educational material on infertility prevention grounded in the PMT. [12, 31–38]. The educational intervention for the intervention group consisted of three one-hour sessions spread over one week. The sessions included lectures, group discussions, Q&A sessions, brainstorming activities, role-playing experiences, and the distribution of educational booklets. The control group did not receive any intervention (Table 1). Two months after the educational intervention was completed, both the intervention and control groups filled out the questionnaire once again. Upon completion of the study, the control group

was given an educational package aimed at enhancing infertility prevention behaviors based on PTM principles.

## Statistical analysis

STATA-17 software was used for data analysis. Chi-Square Test was used to measure the difference between the test and control groups in the pre-intervention phase, in terms of father's occupation, mother's occupation, father's education, mother's education and family income and Independent Sample T Test was used to measure the difference between the two groups in terms of mean age and mean duration of physical activity per week. T-test was used to analyze the difference between the mean scores of each group before and after the intervention. To measure the effect of the intervention on the mean score of PTM constructs and behavior, at first, separate simple linear regression models were used. Then, each basic background characteristic was included in these models to measure the confounding effect of these variables. If they had a significant confounding effect, along with the score of the same construct before the intervention, they were included in multiple linear regression models to measure the final effect of the intervention on that construct. Cohen's D effect size was used in t-tests and R<sup>2</sup> and was used in regression models. It should be noted that the analyzes were performed with the intention to treat (ITT) approach at the error level of 0.05.

## Results

In this study, the data of 99 female participants, including 50 in the control group and 49 in the intervention group, were analyzed. Regarding the education level of the participants' parents, 34.7% of the fathers and 28.6% of the mothers of the intervention group had a university degree, while 36% of the fathers and 32% of the mothers of the control group had a university degree. The monthly family income of about 53% of the participants in the intervention group and 36% of the participants in the control group was higher than 334 dollars. The average age of the participants in the two groups was almost the same, but the average physical activity before the intervention in the test group was slightly higher than the control group. No statistically significant difference was observed in the background characteristics between the two groups under study (Table 2).

Before the intervention, except for response efficiency, the mean score of all constructs in the intervention group was lower than the control group, however, no statistically significant difference was observed in the mean score of the constructs between the two groups under study ( $p^{>0.05}$ ). Also, after the intervention, except for perceived cost, the mean score of all constructs in the intervention group was higher than the control group.

## Table 1 The educational program for Intervention Group

| Sessions           | Objectives   | A summary of topics and activities   | Educational<br>Time<br>(minutes) |
|--------------------|--|--|----------------------------------|
| The first session  | Increasing the perceived susceptibility and perceived<br>severity of infertility in women; Reducing the perceived<br>rewards and reducing the perceived costs      | Topics:<br>- Introduction and communication<br>- Familiarity with risk factors of infertility in women<br>- Prevalence of infertility in women<br>- Discussing the consequences of infertility in individual<br>and social life<br>- Discussing the economic costs of infertility treatment<br>- Discussing wrong behaviors that seem pleasant<br>and the impact of wrong lifestyle on women's fertility<br>- Discussing facilitating physical activity, healthy eating<br>and avoiding harmful substances such as tobacco<br>and alcohol<br>- Discussion on removing obstacles to sexual hygiene,<br>marriage and having children at the right age<br>Training method and teaching aids: lecturing, group<br>discussions, questions and answers using a data projec-<br>tor and the educational booklet   | 60 min                           |
| The second session | Increasing the self-efficacy and response efficiency<br>of infertility prevention behaviors  | Topics:<br>- Introduction and communication<br>- Assuring girls about their ability to maintain<br>and improve their reproductive health<br>- Reassuring girls that they have the necessary ability<br>to move regularly and be physically active and maintain<br>an ideal weight<br>- Assuring girls about having the necessary ability<br>to follow a healthy diet and avoid substances harmful<br>to health<br>- Assuring girls about having the necessary ability<br>to marry and have children at the right age and to be<br>worthy of being a mother<br>- Reassuring that the expected result will be obtained<br>if the correct behavior is performed<br>Training method and teaching aids: substitution experi-<br>ences, lectures and questions and answers, brain-<br>storming and group discussion using the educational<br>booklet, data projector | 60 min                           |
| The third session  | Increasing the motivation of girls to perform infer-<br>tility prevention behaviors and increasing fear<br>about the complications and consequences of infertility | Topics:<br>- Introduction and communication<br>- Motivating girls to improve diet, physical activity,<br>reach ideal weight, reduce consumption of tea, coffee<br>and avoid smoking and alcohol<br>- Motivating girls to plan for marriage and having chil-<br>dren on time and observe sexual hygiene<br>- Providing information to girls about the personal,<br>family and social complications of female infertility<br>and the consequences of infertility for them<br>Training method: group discussions, brainstorming,<br>lectures with questions and answers and using the edu-<br>cational booklet and data projector   | 60 min                           |

A statistically significant difference was observed in the mean score of the majority of constructs including behavior, perceived susceptibility and perceived severity between the two groups under study (p < 0.05). In the control group, no statistically significant difference was observed in the mean score of the constructs before and after the intervention; While in the intervention group, the score of perceived susceptibility, perceived severity, perceived self-efficacy, protection motivation, fear, and behavior after the intervention was 2.75, 1.69, 2.53, 3.91, 1.61 and 2.73 higher than the score before the intervention, and this increase in scores was statistically significant (p < 0.05) (Table 3).

After the intervention and with Adjust for the confounding variables in the Multiple model, the average score of perceived susceptibility, fear and behavior in the test group was 2.16, 1.60 and 1.61 respectively higher than the control group (95%CI=0.28, 4.04, p=0.025),

| Variables                           |                           | Intervention Group<br>(n = 49) | Control Group ( $n = 50$ ) |
|-------------------------------------|---------------------------|--------------------------------|----------------------------|
|                                     |                           | Frequency (%) <sup>a</sup>     |                            |
| Father's Occupation                 | Employee                  | 22 (44.9)                      | 20 (40)                    |
|                                     | Manual worker             | 2 (4.1)                        | 6 (12)                     |
|                                     | Freelance job             | 25 (51)                        | 24 (48)                    |
| Mother's Occupation                 | Employee                  | 38 (77.6)                      | 31 (62)                    |
|                                     | Manual worker             | 7 (14.3)                       | 13 (26)                    |
|                                     | Freelance job             | 4 (8.2)                        | 6 (12)                     |
| Father's education level            | Elementary                | 5 (10.2)                       | 10 (20)                    |
|                                     | High school               | 7 (14.3)                       | 7 (14)                     |
|                                     | Diploma                   | 20 (40.8)                      | 15 (30)                    |
|                                     | College education         | 17 (34.7)                      | 18 (36)                    |
| Mother's education level            | Elementary                | 6 (12.2)                       | 10 (20)                    |
|                                     | High school               | 5 (10.2)                       | 6 (12)                     |
|                                     | Diploma                   | 24 (49)                        | 18 (36)                    |
|                                     | College education         | 14 (28.6)                      | 16 (32)                    |
| Family income                       | Under 167\$               | 5 (10.2)                       | 5 (10)                     |
|                                     | Between 167\$ until 334\$ | 18 (36.7)                      | 27 (54)                    |
|                                     | Above 334\$               | 26 (53.1)                      | 18 (36)                    |
|                                     |                           | $Mean \pm SD^b$                |                            |
| Age                                 |                           | 21.9±3.32                      | 21.26±1.62                 |
| Physical activity: minutes per week |                           | 151.22 + 99.09                 | 137.50+136.39              |

## Table 2 Baseline characteristics in intervention group and control group

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<sup>a</sup> Chi-Square Test

<sup>b</sup> Independent Sample T Test

(95%CI=0.39, 2.80, p=0.010) and (95%CI=0.39, 2.83, p=0.010) (Table 4).

## Discussion

The aim of this study was to assess the impact of an educational intervention grounded in PMT on improving reproductive health protective behaviors in female students. Concerning demographic variables, no noteworthy differences were observed between the intervention and control groups.

The study results indicated a positive impact of an educational intervention on the knowledge and behavior of young girls in embracing reproductive health protective behaviors. Consistent with these findings, Öztürk's study on the effects of an infertility prevention program among female students revealed a significant increase in participants' infertility awareness and favorable attitudes towards infertility [28]. In the study by Chi, participants' knowledge levels about infertility risk factors increased by incorporating these factors into a sexual health program for university students [39].

In numerous countries, one of which is Iran, the conversation and education surrounding reproductive health and related issues, particularly for young girls, are significantly restricted both within households and in society due to being viewed as a social taboo. Consequently, it appears that individuals are more inclined to gather information from dispersed and untrustworthy sources, which often focus on sexual topics and overlook reproductive health matters. While there is opposition in society to providing information on reproductive health to young people, Kashefi's study [21] found that 80% of students disagreed with this perspective. It appears that due to certain cultural factors, individuals, particularly young women, lack adequate knowledge about fertility and its associated issues. The insufficient understanding of how to prevent infertility causes hinders students from effectively safeguarding their reproductive health.

On the other hand, in Nakamura's study [23], acquiring correct knowledge about fertility and timely marriage and childbearing was shown to be an effective tool for planning future life in students. Encouraging students to reflect on their personal lives can cultivate a desire to start a family and have children. It is important to note that educating individuals on fertility through effective methods can prompt them to consider their future personal lives. In today's world, academic and professional commitments often overshadow personal **Table 3** Evaluation of the change in the mean scores of PTM constructs and behavior of participating during the study according to the groups under study

| Participants             |                              | Before the intervention | After the intervention | Mean difference  | Effect size<br>(Cohen's D) | P-Value <sup>a</sup> |
|--------------------------|------------------------------|-------------------------|------------------------|------------------|----------------------------|----------------------|
| Perceived susceptibility | Intervention                 | 29.84±4.71              | 32.59±3.98             | 2.75±1.00        | 0.63                       | 0.009                |
|                          | Control                      | $30.92 \pm 3.85$        | $30.36 \pm 5.24$       | $-0.56 \pm 0.84$ | 0.12                       | 0.512                |
|                          | Mean difference              | $-1.08 \pm 0.86$        | $2.23 \pm 0.93$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.25                    | 0.47                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.213                   | 0.019                  |                  |                            |                      |
| Perceived severity       | Intervention                 | $15.31 \pm 2.97$        | $17.00 \pm 2.27$       | $1.69 \pm 0.59$  | 0.63                       | 0.007                |
|                          | Control                      | $16.08 \pm 2.59$        | $15.02 \pm 3.12$       | $-1.06 \pm 0.63$ | 0.36                       | 0.100                |
|                          | Mean difference              | $-0.77 \pm 0.56$        | $1.98 \pm 0.55$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.27                    | 0.72                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.171                   | 0.001                  |                  |                            |                      |
| Perceived rewards        | Intervention                 | $12.14 \pm 2.06$        | $12.06 \pm 2.98$       | $-0.08 \pm 0.55$ | 0.03                       | 0.884                |
|                          | Control                      | $12.42 \pm 2.49$        | 11.76±3.53             | $-0.66 \pm 0.60$ | 0.21                       | 0.280                |
|                          | Mean difference              | $-0.27 \pm 0.46$        | $0.30 \pm 0.65$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.12                    | 0.09                   |                  |                            |                      |
|                          | P-Value <sup>b</sup>         | 0.548                   | 0.648                  |                  |                            |                      |
| Perceived self-efficacy  | Intervention                 | $26.53 \pm 3.22$        | $29.06 \pm 3.40$       | $2.53 \pm 0.61$  | 0.76                       | < 0.001              |
|                          | Control                      | $26.62 \pm 4.30$        | $27.38 \pm 3.82$       | $0.76 \pm 0.71$  | 0.18                       | 0.295                |
|                          | Mean difference              | $-0.09 \pm 0.76$        | $1.68 \pm 0.72$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.02                    | 0.46                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.907                   | 0.023                  |                  |                            |                      |
| Response efficiency      | Intervention                 | $18.08 \pm 3.80$        | $19.53 \pm 3.13$       | $1.44 \pm 0.79$  | 0.41                       | 0.074                |
|                          | Control                      | $17.76 \pm 2.43$        | $17.82 \pm 3.98$       | $0.06 \pm 0.55$  | 0.01                       | 0.915                |
|                          | Mean difference              | $0.32 \pm 0.64$         | 1.71±0.72              |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.10                    | 0.47                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.617                   | 0.020                  |                  |                            |                      |
| Perceived cost           | Intervention                 | $22.20 \pm 4.20$        | $22.73 \pm 5.08$       | $0.53 \pm 0.86$  | 0.11                       | 0.543                |
|                          | Control                      | $22.74 \pm 3.95$        | $22.96 \pm 4.51$       | $0.22 \pm 0.88$  | 0.05                       | 0.805                |
|                          | Mean difference              | $-0.54 \pm 0.82$        | $-0.23 \pm 0.96$       |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.13                    | 0.04                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.515                   | 0.816                  |                  |                            |                      |
| Protection motivation    | Intervention                 | $25.00 \pm 3.76$        | $28.92 \pm 3.58$       | $3.91 \pm 0.72$  | 0.82                       | < 0.001              |
|                          | Control                      | $25.66 \pm 3.49$        | $26.04 \pm 4.75$       | $0.38 \pm 0.79$  | 0.09                       | 0.634                |
|                          | Mean difference              | $-0.66 \pm 0.73$        | $2.88 \pm 0.84$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.18                    | 0.68                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.368                   | 0.001                  |                  |                            |                      |
| Fear                     | Intervention                 | $19.49 \pm 2.98$        | $21.10 \pm 2.84$       | $1.61 \pm 0.56$  | 0.55                       | 0.006                |
|                          | Control                      | $20.12 \pm 2.47$        | $19.56 \pm 3.15$       | $-0.56 \pm 0.54$ | 0.19                       | 0.306                |
|                          | Mean difference              | $-0.63 \pm 0.55$        | $1.54 \pm 0.60$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.23                    | 0.51                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.255                   | 0.012                  |                  |                            |                      |
| Behavior                 | Intervention                 | $22.98 \pm 2.92$        | $25.71 \pm 3.20$       | $2.73 \pm 0.66$  | 0.89                       | < 0.001              |
|                          | Control                      | $23.92 \pm 2.88$        | $23.86 \pm 3.01$       | $0.06 \pm 0.66$  | 0.02                       | 0.929                |
|                          | Mean difference              | $-0.94 \pm 0.58$        | $1.85 \pm 0.62$        |                  |                            |                      |
|                          | Effect size (Cohen's D)      | 0.32                    | 0.59                   |                  |                            |                      |
|                          | <i>P</i> -Value <sup>b</sup> | 0.111                   | 0.004                  |                  |                            |                      |

<sup>a</sup> Paired Sample T-Test

<sup>b</sup> Independent Sample T-Test

| Variables  |              | Simple model |        |       |                               |                              | Multiple mode     | 6      |       |                               |                              |
|--|--------------|--------------|--------|-------|-------------------------------|------------------------------|-------------------|--------|-------|-------------------------------|------------------------------|
|  |              | Coefficient  | 95% CI |       | Effect size (R <sup>2</sup> ) | <i>P</i> -Value <sup>a</sup> | Coefficient       | 95% CI |       | Effect size (R <sup>2</sup> ) | <i>P</i> -Value <sup>a</sup> |
|  |              |              | Lower  | Upper |                               |                              |                   | Lower  | Upper |                               |                              |
| Perceived susceptibility                           | Control      | Reference    |        |       | 0.05                          |                              | Reference         |        |       | 0.05                          |                              |
|  | Intervention | 2.23         | 0.37   | 4.09  |                               | 0.019                        | 2.16 <sup>b</sup> | 0.28   | 4.04  |                               | 0.025                        |
| Perceived severity                                 | Control      | Reference    |        |       | 0.11                          |                              | Reference         |        |       | 0.16                          |                              |
|  | Intervention | 1.98         | 0.88   | 3.07  |                               | 0.001                        | 1.80 <sup>b</sup> | 0.72   | 2.88  |                               | 0.001                        |
| Perceived rewards                                  | Control      | Reference    |        |       | 0.01                          |                              | Reference         |        |       | 0.06                          |                              |
|  | Intervention | 0.30         | -1.00  | 1.60  |                               | 0.648                        | 0.02 <sup>c</sup> | -1.28  | 1.34  |                               | 0.965                        |
| Perceived self-efficacy                            | Control      | Reference    |        |       | 0.05                          |                              | Reference         |        |       | 0.25                          |                              |
|  | Intervention | 1.68         | 0.23   | 3.12  |                               | 0.023                        | 1.72 <sup>d</sup> | 0.29   | 3.16  |                               | 0.019                        |
| Response efficiency                                | Control      | Reference    |        |       | 0.05                          |                              | Reference         |        |       | 0.05                          |                              |
|  | Intervention | 1.71         | 0.27   | 3.14  |                               | 0.020                        | 1.71 <sup>b</sup> | 0.26   | 3.15  |                               | 0.021                        |
| Perceived cost                                     | Control      | Reference    |        |       | 0.00                          |                              | Reference         |        |       | 0.22                          |                              |
|  | Intervention | -0.22        | -2.14  | 1.69  |                               | 0.816                        | 0.33 <sup>e</sup> | -1.54  | 2.21  |                               | 0.725                        |
| Protection motivation                              | Control      | Reference    |        |       | 0.10                          |                              | Reference         |        |       | 0.11                          |                              |
|  | Intervention | 2.87         | 1.19   | 4.56  |                               | 0.001                        | 2.93 <sup>b</sup> | 1.24   | 4.62  |                               | 0.001                        |
| Fear   | Control      | Reference    |        |       | 0.06                          |                              | Reference         |        |       | 0.06                          |                              |
|  | Intervention | 1.54         | 0.34   | 2.74  |                               | 0.012                        | 1.60 <sup>b</sup> | 0.39   | 2.80  |                               | 0.010                        |
| Behavior   | Control      | Reference    |        |       | 0.08                          |                              | Reference         |        |       | 0.12                          |                              |
|  | Intervention | 1.85         | 0.61   | 3.09  |                               | 0.004                        | 1.61 <sup>b</sup> | 0.39   | 2.83  |                               | 0.010                        |
| <sup>a</sup> Linear regression at level $\alpha =$ | =0.05        |              |        |       |                               |                              |                   |        |       |                               |                              |

Table 4 The effect of intervention on PMT constructs and behavior using simple and multiple linear regression models

<sup>b</sup> Adjusted only for the score of the same construct before the intervention

<sup>c</sup> Adjusted for mean score of perceived rewards before the intervention, mother's occupation and father's education level

<sup>d</sup> Adjusted for mean score of perceived rewards before the intervention, age, mother's occupation, mother's education level and family income

e Adjusted for mean score of perceived cost before the intervention, age, physical activity, mother's occupation, father's occupation, mother's education level and family income

matters, particularly for women, such as marriage and child-rearing.

After the intervention, perceived susceptibility and perceived severity, perceived self-efficacy, protection motivation and fear constructs were significantly improved in the intervention group compared to the control group. These results are in line with the findings of Hoseini's [36], Sharifi [26] and Ghahremani [40]. Havaei's study on the effect of training based on protective motivation theory on the self-care of health of female students showed that self-efficacy and response effectiveness scores increased in the intervention group [38]. The results of Jahromi, Kazemi and Norozi studies have shown the effect of educational intervention on improving women's self-efficacy in adopting healthy behaviors [41-43]. Individuals with high self-efficacy see themselves as more capable of maintaining their health and are more likely to engage in health-oriented behaviors.

According to the results, the educational intervention could not significantly improve the perceived rewards and perceived cost constructs. These findings are in line with the results of Havaei's study [38]. Although it was in contradiction with the results of Hoseini's study [36]. It should be said that the structure of the perceived reward is related to the enjoyment of some behaviors. Intervention programs should recommend alternative enjoyable behaviors and help individuals in substituting these behaviors. Additionally, to minimize perceived costs, community-oriented interventions are necessary, particularly in the realm of marriage facilitation, alongside education. Ultimately, the study findings revealed the impact of educational interventions on enhancing reproductive health protective practices among female students. Similar results were obtained in the studies of Hosseini [36] and Sharifi [26] on women using PMT.

The study's strength lies in its focus on protecting reproductive health in response to Iran's declining fertility rate and issues arising from the aging population. Additionally, incorporating a behavioral dimension alongside PMT constructs contributed to improved outcomes. The study's design of the educational intervention, based on information gathered from participants during the pre-test phase and reliable scientific sources, as well as its systematic and thorough implementation, were additional strengths of the research. One limitation of this study is the inability to follow up with participants over an extended period to observe the impact of the intervention on future infertility prevention behaviors. Additionally, the reliance on self-reported questionnaires and the inability to consider certain crucial demographic variables, such as marital status, are also limitations of this study.

## Conclusion

The use of PMT-based educational interventions proved effective in encouraging female students to adopt reproductive health protective behaviors. Given the significance of fertility preservation for young women and the challenges associated with infertility, it is recommended to implement PMT-based educational programs to safeguard women's reproductive health. It appears that adjusting the constructs of perceived rewards and perceived costs necessitates offering behavioral incentives and implementing reforms in societal norms to make it easier for individuals to opt for healthy behaviors. Future studies should consider not only educational interventions aimed at enhancing individual behavior but also social modifications to promote and sustain healthy behaviors.

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#### Informed consent

All participants provided written informed consent.

#### Authors' contributions

Conceptualization: N SH, Z J; Data curation: Z J, A B, M V, H S; Formal analysis: R B, N SH; Methodology: N SH, Z J, R B; Project administration: N SH, A B, M V; Writing–original draft: N SH, R B; Writing–review & editing: all authors.

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#### Data availability

The datasets generated and analyzed during the current study are not publicly available because they contain raw data from study participants, and sharing these data requires participants' permission. But are available from the corresponding author on reasonable request.

## Declarations

#### Ethics approval and consent to participate

Ethical approval was obtained from the Human Research Ethics Committee at the Khomein University of Medical Sciences (Code IR.KHOMEIN.REC.1402.027). All study participants provided written informed consent. Confidentiality and anonymity were ensured. All procedures performed in studies involving human participants were by the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare no competing interests.

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