Effect of Interactive Online Preventive Program Regarding Osteoporosis on Female Students' Knowledge, Health belief, Self-efficacy and Behavior

Samar Mohammed Abdel-kader Alngery[1], Mohamed Saad Abo Elsoud[2]

[1,2]Lecturers of Family and Community Health Nursing, Faculty of Nursing, Suez Canal University, Egypt

Corresponding author: Dr. Samar Mohammed Abdel-kader Alngery

Email: Samar_Alngery@nursing.suez.edu.eg

Abstract

Background: Osteoporosis, a common chronic disease associated with higher mortality and lower quality of life, is a major global health issue but largely preventable with early intervention. Adolescence is a key period for prevention, as lifestyle choices made during this stage greatly influence bone development. Promoting knowledge, positive health beliefs, and protective behaviors during adolescence is crucial for lifelong bone health. **Aim:** The aim of the study was to evaluate the effect of interactive online preventive program regarding osteoporosis among female students at Suez Canal University. **Subjects and Method:** A quasi-experimental one-group pretest-posttest design was employed in this study, which was conducted at Suez Canal University across four randomly selected faculties. A total of 192 female students were selected from these faculties using a multistage stratified random sampling technique. **Tools:** One tool was used to collect the data: a self-administered questionnaire comprising five parts; Part I: Demographic data, Part II: Osteoporosis Knowledge Test, Part (III): Osteoporosis health belief scale, Part (IV): Osteoporosis Self-Efficacy Scale, Part (V): Osteoporosis Preventing Behaviors Survey. **Results:** A statistically significant improvement ($p < .001$) was found in female students' knowledge, health beliefs, self-efficacy, and behaviors related to osteoporosis after participating in the interactive online preventive program, including greater perceived benefits of calcium and vitamin D intake, fewer barriers to healthy behaviors, and higher health motivation. **Conclusion:** The program revealed strong positive correlations among health beliefs, knowledge, self-efficacy, and preventive practices. **Recommendations:** Continue and regularly update the interactive osteoporosis prevention program to reinforce knowledge and sustain healthy behaviors among students.

Keywords: Behavior, Health belief, Knowledge, Osteoporosis, Self-efficacy.

Introduction

Osteoporosis (OP) represents a significant and increasingly concerning public health challenge that can be effectively prevented through the adoption of healthy lifestyle practices during adolescence ***(Khazaeian, Sanavi, Ansari & Mirshekari, 2021).***

Osteoporosis is a chronic condition characterized by a decrease in bone density and deterioration of bone microarchitecture, leading to compromised bone strength and an elevated risk of fractures. Although it affects people of all age groups, genders, and ethnicities, Caucasians (white people) and older people and women experience it more frequently ***(Moradnejad et al., 2020).***

This disease, often referred to as the "silent thief," is a progressively advancing disorder characterized by the deterioration of both bone mass and structural integrity. It progresses insidiously, typically without noticeable symptoms, and often becomes clinically apparent only through fractures in the absence of preventive measures or treatment. The hazard of osteoporosis lies in its propensity to cause fractures of the hip, vertebrae, and wrist, which may result in permanent disability ***(Sekiya, 2023).*** Multiple predisposing factors can potentiate the risk of developing osteoporosis. Non-modifiable risk factors include Caucasian ethnicity and a positive family history of the disease, while modifiable factors encompass inadequate dietary intake of calcium and vitamin D, insufficient physical activity, low body mass index, excessive alcohol consumption, and tobacco use ***(Özmen et al., 2024).***

Though osteoporosis remains incurable, preventive measures can effectively mitigate its development across the lifespan. These preventive strategies encompass regular physical activity alongside optimal consumption of calcium and vitamin D, and implementation of fall prevention techniques. Cessation of alcohol consumption and tobacco use contributes significantly to risk reduction. Furthermore, regular participation in weight-bearing physical activities, including exercises like running and stair ascent, aerobics, isometric exercises, and swimming—for a minimum duration of 30 minutes daily serves as a valuable preventive measure against bone density deterioration ***(Valenzuela-Martínez, Ramírez-Expósito, Carrera-González, & Martínez-Martos, 2023).***

Adolescence represents a pivotal developmental phase characterized by substantial biological, cognitive, and social transformations. During this

critical period, individuals attain significant cognitive maturation, enabling complex reasoning capabilities. This developmental window constitutes a formative interval during which both health-promoting and health-compromising behavioral patterns crystallize, frequently persisting throughout the lifespan. Given that structured educational engagement represents a defining characteristic of adolescent experience, it presents an optimal vehicle for behavioral intervention implementation. Since education is an important characteristic of them, it can be used as a useful tool to encourage protective behavior at this age ***(Khazaeian et al, 2021).***

Increasing factual health knowledge, addressing incorrect health beliefs, and promoting bone-protective practices are effective measures for building and supporting bone resilience throughout life a person's life, especially in adolescent females who are believed to be not only more vulnerable but are also future mothers. Consequently, maternal health metrics exhibit substantial influence on familial health indicators through intergenerational pathways ***(Chan, Mohamed, Ima-Nirwana, & Chin, 2018).***

The Health Belief Model (HBM) represents a well-established theoretical framework extensively utilized to elucidate health-related behavioral patterns. Interventions structured according to HBM principles demonstrate efficacy and cost-effectiveness in augmenting knowledge acquisition and behavioral implementation necessary for facilitating sustainable lifestyle modifications, including enhanced calcium consumption and participation in weight-bearing physical activities—both critical components for prevention of osteoporosis ***(Ali, Mekhamier, & El Sayed, 2020).*** Therefore, the Health Belief Model can serve as a framework for osteoporosis prevention by focusing on two key strategies: enhancing awareness about osteoporosis and promoting preventive actions and self-efficacy, which support attitude shifts and behavior change. ***(Ahmed, Elsayied, Mohamed, & Salama, 2022).***

Significance of the study

Preventing osteoporosis in adolescents, particularly girls, is of paramount importance for lifelong skeletal health. Adolescence represents a critical window for bone mass accumulation, with approximately 40% of total adult bone mass acquired during this period, ***(Tian & Yu, 2022).*** Globally, osteoporosis affects a significant portion of the population. Epidemiological data demonstrate that osteoporotic fractures impact

approximately 33.3% of females and 20% of males over the age of 50 during their remaining lifespan. Specifically, within the Egyptian demographic context, research indicates osteoporosis prevalence rates of 28.4% among females and 21.9% among males. Additionally, osteopenia has been documented in 53.9% of females and 26% of males according to established diagnostic criteria ***(El Miedany, Gadallah, & Toth, 2022).***

A systematic review by ***Matsumoto, Hagino, Wada, and Kobayashi (2022),*** found that lifestyle interventions during adolescence, incorporating sufficient intake of calcium and vitamin D, as well as engaging in regular weight-bearing exercise, can increase peak bone mass by 5-10%. This increase translates to a potential 50% reduction in fracture risk later in life, underscoring the long-term benefits of early prevention strategies ***(Matsumoto et al., 2022).***

Aim of the study

The aim of the study was to evaluate the effect of interactive online preventive program regarding osteoporosis among female students at Suez Canal University.

Objectives

- Assess knowledge, health belief, self-efficacy and behavior regarding osteoporosis prevention among female students (Pre\Post) implementation of the program.
- Design interactive online preventive program regarding osteoporosis among female students according to their needs.
- Implement interactive online preventive program regarding osteoporosis among female students according to their needs.
- Evaluate interactive online preventive program among female's knowledge, health belief, self-efficacy and behavior regarding prevention of osteoporosis.

Research hypothesis

H0: There is no significant difference in knowledge, health belief, self-efficacy, and behavior regarding osteoporosis among female students pre- and post-participation in the interactive online preventive program.

H1: There is a significant difference in knowledge, health beliefs, self-efficacy, and behaviors regarding osteoporosis among female students pre- and post-participation in the interactive online preventive program.

Subjects and Methods

Study design: A one-group quasi-experimental design with (pre-post) evaluation was used in the study.

Setting*:* This study was applied at Suez Canal University, in four faculties that were randomly selected (faculties of

Nursing, Agriculture, Al-Alsun, and Tourism and Hotels).

Sample*:* A multistage stratified random sampling technique was utilized to select the study sample through the **following stages**

Stage 1: Out of 21 faculties at Suez Canal University, 4 faculties (Nursing, Agriculture, Al-Alsun, and Tourism and Hotels) were randomly selected, representing approximately 20% of the total.

Stage 2: Within the selected faculties, first-year students were identified as the target population.

Stage 3: A random sample comprising 25% of female students from the first academic year was selected from each of the four faculties.

Stage 4: Students with musculoskeletal disorders were excluded based on predefined purposive exclusion criteria, resulting in a final sample of 192 female students.

The sample size was determined using G-power analysis software

A priori: Compute required sample size (G power analysis)

Effect size f 0.25
α err probability 0.05
Power (1-β err probability) .90
Number of groups 4
Total sample size 192

Inclusion Criteria

Female students enrolled in the first academic year of the four previously selected faculties at Suez Canal University.

Exclusion Criteria

Female students who had been diagnosed with musculoskeletal disorders (MSDs) were excluded to eliminate potential confounding health-related factors.

Tools for data collection: Data was collected by using one tool.

Tool (1): A Self-Administered Questionnaires, It was include five parts as the following:

Part I: This part was developed by the researchers following an extensive review of the literature, particularly that of **Althobiti, Al Nagshabandi, and Mohamed (2020).** It focuses on demographic data of female students, including: age (in years), marital status, faculty name, prior knowledge of osteoporosis, and family history of the condition….etc.).

Part II: Osteoporosis Knowledge Test (OKT). It was adopted from ***Kim, Horan, & Gendler, (1991a).*** The OKT has been revised in 2012 and validated by ***(Gendler et al., 2015).*** After the validation OKT has 32 questions leading to possible total score of 0-32. OKT has two scales: nutrition and exercise. Questions from 1-11 are about general knowledge on OP. While questions 12-17 and 30-32 are about exercise. The nutrition section included questions from 18-29. A score of 1 was

assigned for each correct answer, whereas incorrect responses and "don't know" answers were scored as "zero". The maximum attainable score for this tool was 32; this score calculated and categorized as

Knowledge Level	Score Range	Percentage Range	Points (out of 32)
Poor	0-12.7	< 40%	< 12.8
Moderate	12.8-17.9	40-59%	12.8 – 17.9
Good	18-32	≥ 60%	≥ 18

Part (III): Osteoporosis health-belief scale (OHBS)

This scale was adopted from ***Kim et al, (1991).*** The original Osteoporosis Health Belief Scale (OHBS) is a 42-item instrument comprising seven subscales: Susceptibility (items 1–6), Seriousness (items 7–12), Benefits of Exercise (items 13–18), Benefits of Calcium Intake (items 19–24), Barriers to Exercise (items 25–30), Barriers to Calcium Intake (items 31–36), and Health Motivation (items 37–42). The scale was later modified to include two additional subscales—Benefits of Vitamin D (items 43–48) and Barriers to Vitamin D (items 49–54)—which were adapted from the calcium-related items, resulting in the OHBS-D version. The OHBS employs a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." Responses are scored from 1 (strongly disagree) to 5 (strongly agree). Each subscale yields a score between 6 and 30, with lower scores reflecting low perception and higher scores reflecting high perception. The total possible score for the modified scale ranges from 54 to 270.

Part (IV): Osteoporosis Self-Efficacy Scale (OSES)

Self-efficacy refers to an individual's belief in their capacity to successfully perform a specific task ***(Insel & Roth, 2010).*** The Osteoporosis Self-Efficacy Scale (OSES) is a 12-item tool comprising two subscales: the Exercise Self-Efficacy Subscale (items 1–6) and the Calcium Intake Self-Efficacy Subscale (items 7–12). The OSES is grounded in constructs such as perceived susceptibility and seriousness, perceived barriers and benefits, health motivation, and an individual's confidence in their ability to engage in osteoporosis-preventive behaviors, serving as a predictor of potential health behavior ***(Ford, Bass, Zhao, Bai, & Zhao, 2011).*** The exercise subscale evaluates an individual's confidence across different aspects of an exercise regimen, including initiating a new program, modifying exercise habits, exerting appropriate effort, completing challenging exercises, managing time, and adhering to recommended routines ***(Ford et al., 2011).*** Initially, participants rated their confidence by

placing a mark on a continuum between "not at all confident" and "very confident." However, ***Edmonds (2009)*** found this format potentially confusing for participants and revised the scale to a Likert-type format with response options ranging from "strongly disagree" to "strongly agree," while maintaining the original items. This study adopted the modified version developed by ***Edmonds (2009).*** Higher scores on the scale indicate greater perceived self-efficacy in performing osteoporosis-related preventive behaviors.

Part (V): Osteoporosis Preventing Behaviors Survey (OPBS)

The Osteoporosis Preventing Behaviors Survey (OPBS), developed by ***Doheny and Sedlak in 1995,*** was originally a 39-item instrument aimed at evaluating behaviors related to osteoporosis prevention, such as physical activity, calcium intake, and risk factors like smoking and medication use. In ***2009, Edmonds*** revised the tool into a streamlined eight-item version focused specifically on young adults by removing items related to menopause. The revised OPBS assesses dietary calcium intake, calcium supplement use, and both weight-bearing and non-weight-bearing physical activity through multiple-choice and yes/no questions. It also includes a seven-day physical activity recall (7dPAR) to estimate weekly MET-minutes, aligning with WHO physical activity guidelines. Scoring is based on intake adequacy and exercise frequency, with higher scores indicating healthier behaviors. The final item captures perceived changes in physical activity over time, summarized by frequency and percentage.

Tools validity and reliability

The validity of the translated study tool was evaluated by a panel of three experts from Suez Canal University, including two assistant professors specializing in Family and Community Health Nursing and one from Medical and Surgical Nursing. They evaluated the tool's lucidity, relevance, comprehensiveness, and construction. This thorough validation process, focusing on language clarity, applicability to study objectives, inclusion of essential elements, and overall structure, took two weeks to complete. The experts' collective assessment confirmed the tool's validity for research use.

Reliability was determined through the calculation of Cronbach's alpha coefficient, which demonstrated that the tool possessed acceptable internal consistency, as indicated by the following results:

Tool (1) Part II, Osteoporosis Knowledge Test (OKT) for female students, confirmed acceptable internal consistency with Cronbach's α of 0.79.

The reliability of Tool (1) Part III, namely Osteoporosis Health Belief Scale (OHBS), was good with α = 0.88, and Tool (1) Part IV, namely Osteoporosis Self-Efficacy Scale (OSES), showed highly acceptable internal consistency with α = 0.87. Additionally, the Cronbach's alpha coefficient for Tool (1) Part V, Osteoporosis Preventing Behaviors Survey (OPBS), was acceptable with α = 0.70.

Pilot study: A pilot study was conducted on 10% (n = 19) of the randomly selected female students to evaluate the relevance, clarity, and feasibility of the study tool, as well as to estimate the time required to complete it. These participants were subsequently excluded from the main study sample. The preliminary study was carried out over a two-week period, starting on October 1, 2021.

Procedure: The program was initiated following the receipt of official authorization, conveyed through a letter from the Dean of the Faculty of Nursing to the deans of the respective faculties. Subsequently, the program was implemented. The entire study spanned approximately six months, covering the phases of preparation, data collection, implementation, and evaluation. It began in early October 2021 and concluded at the end of March 2022. The program was conducted in four sequential phases, as outlined below:

Assessment Phase: Data collection was initiated by the researchers following the acquisition of official approval to conduct the study and the completion of the development and finalization of the data collection tool. To facilitate communication with the participating female students, a Whats-App group was established that included all of them. This allowed the researchers to share information about meeting times and address any questions or concerns the students might have. The data was collected through online questionnaires sent to the female students, but only after obtaining their consent to participate in the study and clearly explaining its purpose. The initial assessment phase (pre-test) was completed over two weeks.

Planning Phase: Based on the findings from the pre-test phase and insights drawn from recent scholarly literature, an interactive online osteoporosis prevention program was designed and developed. The program covered an overview of osteoporosis, its risk factors, the benefits and barriers of calcium intake and exercise,

calcium-rich foods, the body's calcium requirements, and preventative measures to prevent osteoporosis. Additionally, a simple booklet on the same topic was created as a preventive resource for the target audience. The researchers also prepared the program content in PowerPoint presentations and videos. The planning phase took approximately two weeks.

Implementation Phase: To implement the program, students were divided into four groups, with each group attending four electronic sessions (Zoom and Microsoft Teams Meetings), each lasting 30 to 45 minutes.

Implementation Technique

1. **First Session (Knowledge Development):** This session focused on enhancing awareness of osteoporosis, including its nature, severity, susceptibility, preventive behaviors, complications, the importance of exercise, sun exposure, and health beliefs.
2. **Second Session (Dietary Education and Training):** The goal of this session was to educate female students on making healthy dietary choices. It included video demonstrations on proper nutrition and calcium intake. Additionally, students were shown pre- and post-treatment images of patient bones to reinforce their understanding of osteoporosis susceptibility.
3. **Third Session (Exercise and Osteoporosis Prevention):** This session emphasized the contribution of physical activity in preventing osteoporosis, highlighting the benefits and challenges of exercise, adherence to recommended routines, and self-efficacy in maintaining a proper exercise regimen.
4. **Fourth Session (Review and Educational Resources):** A summary of the previous sessions was provided, and female students received educational pamphlets for further learning and reinforcement.

The implementation phase lasted approximately four months, spanning from mid-November 2021 to mid-March 2022.

Evaluation Phase: The effectiveness of the interactive online preventive program on osteoporosis among female students was evaluated immediately after its implementation (post-test) using the previously mentioned tools. The evaluation phase (post-test) was conducted for all groups and took two weeks to complete.

Ethical considerations: The researchers obtained ethical approval to conduct this study from the Scientific Research Ethics Committee at the Faculty of Nursing, Suez Canal University, with code 112 and approved date 6/2021. Informed

consent was acquired from the female students after a detailed explanation of the study's objectives and nature. Participants were assured that their information would be kept confidential. Additionally, the students were clearly informed that their participation was completely voluntary, and were explicitly told that they could withdraw from the study at any time without facing any consequences. Upon the completion of the study, the scientific materials for the program were sent to the students.

Statistical analysis: Data entry and analysis were performed using version 25.0 of the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were computed, including means and standard deviations for quantitative variables, and frequencies and percentage distributions for qualitative variables. To assess changes between pre- and post-program measurements, paired sample t-tests were conducted, with statistical significance set at $p \leq 0.05$. The magnitude of program effects was quantified using Cohen's d effect size measurements. After confirming normal distribution of continuous data, Pearson correlation coefficients were computed to examine relationships between quantitative variables. Statistical significance was considered at $p < 0.05$, with high significance designated at $p < 0.001$.

Results

Table 1, the studied sample primarily consisted of female students, with a mean age of 19.22 ± 0.55 years and an age range of 18 to 20 years. Regarding faculty distribution, 30.2% were from the Faculty of Agriculture, followed by 27.6% from Nursing and 25.0% from Language, while 17.2% were from Tourism. Moreover, 69.3% of female students resided in urban areas, and approximately 98.4% were single. Additionally, 16.1% of them reported a family history of osteoporosis.

Figure 1 illustrates that 58.3% of the studied female students reported having information about osteoporosis, while 41.7% indicated they had no knowledge of the condition.

Table 2 indicates a statistically significant difference ($p < .001$) was observed in the studied female students' total mean knowledge score about osteoporosis post-implementation of the program compared to pre-implementation.

Table 3 demonstrates that a statistically significant improvement ($p \leq 0.05$) in the perceptions of the studied female students regarding the benefits of calcium and vitamin D intake, a reduction in barriers to exercise, calcium, and vitamin D intake, as well as an increase in health motivation.

However, perceived seriousness and susceptibility to osteoporosis slightly decreased.

Table 4 shows that the total self-efficacy score increased from 42.41 ± 6.73 to 44.78 ± 5.28 following the program's implementation, indicating a moderate overall effect on improving osteoporosis-related self-efficacy. This increase was statistically significant ($p \leq .05$), highlighting the program's effectiveness in encouraging positive health behaviors.

Table 5 indicates that a highly statistically significant ($p < .001$) in the osteoporosis preventive behaviors (OPBS) of the studied female students post implementation of the program.

Table 6 presents the correlation among Osteoporosis Preventive Behaviors (OPBS), Health Beliefs (HBS), knowledge, and self-efficacy in the studied female students (n=192) following the implementation of the program. As illustrated in the table, a strong positive correlation is evident between HBS and self-efficacy ($r = 0.400$, $p < 0.001$) and a moderate correlation between knowledge and self-efficacy ($r = 0.375$, $p < 0.001$). Also, A moderate positive correlation exists between OPBS and knowledge ($r = 0.259$, $p < 0.001$) and OPBS and self-efficacy ($r = 0.369$, $p < 0.001$).

Table (1): Percentage distribution of studied female students according to their demographic data (n=192)

Items	No.	%
Age (Years)		
Mean ± SD	**19.22±.55**	
Range	**18-20**	
Faculty		
Nursing	**53**	**27.6**
Agriculture	**58**	**30.2**
Tourism	**33**	**17.2**
Language	**48**	**25.0**
Residence		
Urban	**133**	**69.3**
Rural	**59**	**30.7**
Marital status		
Single	**189**	**98.4**
Married	**3**	**1.6**
Family history of osteoporosis as the female students reported		
Yes	**31**	**16.1**
No	**161**	**83.9**

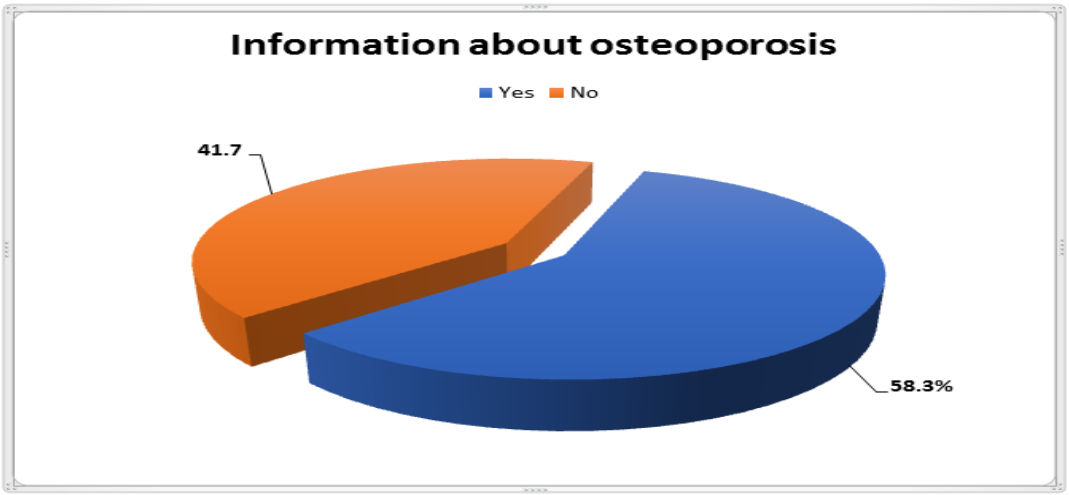

Figure (1): Distribution of studied female students according to their information about osteoporosis (n=192)

Table (2): Mean scores of the studied female students according to their knowledge regarding osteoporosis pre and post implementation of the program (n=192)

Items	Pre-program implementation	Post-program implementation	Test	P value
	Mean ±SD	Mean ±SD		
1. General knowledge	1.33±.81	2.45±.68	18.76	**<.001***
2. Risk factors	2.88±2.32	7.94±1.77	37.27	**<.001***
3. Exercise	2.49±1.22	4.93±1.06	25.73	**<.001***
4. Nutrition				
a. Calcium	3.09±1.32	5.89±.92	30.96	**<.001***
b. Vitamin D	2.33±1.28	4.03±.95	19.99	**<.001***
Total Score (32 Questions)	12.12±2.18	25.24±3.60	17.07	**<.001***

Test is paired sample t test *: Statistically significant at p ≤ 0.05

Table (3): Mean scores of female students' osteoporosis health beliefs (OHBS): pre and post implementation of the program (n=192)

Items	Pre	Post	t test	P value	Effect size (d)
	Mean ±SD	Mean ±SD			
1. Susceptibility	16.23±4.74	15.12±3.97	7.367	**<.001***	.25
2. Seriousness	18.04±4.43	15.98±3.50	10.246	**<.001***	.52
3. Benefits exercise	23.69±4.08	24.03±2.82	1.408	**.161**	.1
4. Benefits of calcium intake	22.55±3.61	23.71±2.91	7.805	**<.001***	.36
5. Benefits of vitamin D intake	22.31±3.89	24.17±3.34	8.427	**<.001***	.55
6. Barrier exercise	16.31±4.09	15.27±3.22	7.144	**<.001***	.30
7. Barrier calcium intake	15.97±4.11	14.33±3.30	9.994	**<.001***	.47
8. Barrier vitamin D intake	17.22±3.15	16.17±2.29	5.563	**<.001***	.40
9. Health motivation	20.70±3.45	22.05±2.75	11.417	**<.001***	.46
Total	173.03±18.71	170.83±13.48	3.098	**.002***	.14

t is paired sample t test *: Statistically significant at p ≤ 0.05 ; d is Cohen's effect size

Table (4): Mean scores of female students' osteoporosis self-efficacy: pre and post implementation of the program (n=192)

Items	Pre	Post	t test	P value	Effect size (d)
	Mean ±SD	Mean ±SD			
1. Begin a new or different exercise program	3.54±83	3.68±.68	3.500	**.001***	.20
2. Change exercise habits	3.33±.95	3.42±.84	3.498	**.001***	.11
3. Put forth the effort required to exercise	3.63±.82	3.72±.64	3.641	**<.001***	.14
4. Do exercises even if they are difficult	3.46±.91	3.55±.81	4.054	**<.001***	.11
5. Exercise for appropriate length of time	3.72±.84	3.81±.67	3.657	**<.001***	.13
6. Do the type of exercise that I am supposed to do	3.65±.76	3.71±.69	2.944	**.004***	.10
7. Increase calcium intake	3.46±.91	3.77±.91	5.692	**<.001***	.44
8. Change my diet to include more calcium foods	3.53±.81	3.81±.79	5.688	**<.001***	.35
9. Eat calcium rich foods as often as I am supposed	3.42±.91	3.85±.87	6.440	**<.001***	.49
10. Select appropriate foods to increase my calcium intake	3.55±.80	3.81±.71	5.848	**<.001***	.37
11. Stick to diet which gives an adequate amount of	3.53±91	3.81±.83	5.137	**<.001***	.34
12. Obtain foods that give an adequate amount of calcium	3.58±.79	3.83±.73	5.162	**<.001***	.32
Total self- efficacy	42.41±6.73	44.78±5.28	10.640	**<.001***	.40

t is paired sample t test *: Statistically significant at p ≤ 0.05 ; d is Cohen's effect size

Table (5): Total mean scores of female students' osteoporosis preventing behaviors (OPBS): pre and post implementation of the program (n=192)

Item	Pre mean±SD	Post mean±SD	95% Confidence Interval of the Difference		t test	P value
			lower	Upper		
Total mean scores	11.41±4.17	13.28±3.75	1.56	2.17	12.102	**<.001***
Effectiveness (Mean difference)	1.86±2.13					

t is paired sample t test ; *highly statistically significant at p <.001

Table (6): Correlation between OPBS, OHBS, knowledge and self-efficacy of studied female students' post implementation of the program (n=192)

Items		OPBS	HBS	knowledge	Self-efficacy
OPBS	Pearson Correlation		.092	.259**	.369**
	Sig. (2-tailed)		.204	<0.001	<0.001
HBS	Pearson Correlation	.092		.215**	.400**
	Sig. (2-tailed)	.204		.003	<0.001
knowledge	Pearson Correlation	.264**	.215**		.375**
	Sig. (2-tailed)	<0.001	.003		<0.001
Self-efficacy	Pearson Correlation	.282	.400	.375	
	Sig. (2-tailed)	<0.001	<0.001	<0.001	

****. Correlation is significant at the 0.01 level (2-tailed).**

Discussion

Osteoporosis is a chronic, asymptomatic condition that often remains undiagnosed until a fracture occurs. Consequently, routine screening and adherence to Osteoporosis Preventive Behaviors (OPB) are fundamental to effective for disease prevention and management. The adoption of OPB is significantly influenced by an individual's level of knowledge and health beliefs ***(Elgzar, Nahari, Sayed, & Ibrahim, 2023).***

Bone strength is determined by various factors throughout an individual's lifespan. Non-modifiable determinants include age, sex, genetic predisposition, and ethnicity, whereas modifiable factors encompass dietary intake, physical activity, and sunlight exposure. Therefore, individuals at elevated risk must possess comprehensive knowledge and well-informed health beliefs regarding osteoporosis to implement proactive preventive strategies ***(Mortada, El Seifi, & Abdo, 2020).***

The aim of this study was to evaluate the effect of interactive online preventive program regarding osteoporosis among female students at Suez Canal University.

Based on the demographic data of the female students included in the study, it's revealed that the mean age of them was 19.22±0.55 years. The majority was single, and approximately one-fifth reported a family history of osteoporosis. These findings are in agreement with those reported by ***Mohammed & Shehata (2019),*** who studied "Evaluation of Health Education Program on Knowledge, Attitude and Practice of Female adolescents regarding Osteoporosis Prevention, Egypt" Who found a mean age of 19.07 ± 0.7 years, with most participants being single.

The findings of the current study revealed a significant increase in overall osteoporosis knowledge among the studied female students after the implementation of the program (P <.001). This finding is similar to the results reported by ***Abdolalipour & Mirghafourvand, (2021),*** who studied "Effect of education on preventive behaviors of osteoporosis in adolescents: A systematic review and meta-analysis" found significant differences in knowledge between the education and control groups (SMD = 1.76, 95% CI = 1.10 to 2.42, P < 0.0001).

Additionally, a study performed in Iran by ***Pakyar, Poortaghi, Pashaeypoor, and Sharifi (2021)*** titled "Effect of educational program based on theory of planned behavior on osteoporosis preventive behaviors: a randomized clinical trial" noted that the intervention group showed a substantial increase in

knowledge scores after the program ($p < 0.05$).

From the researchers' point of view; the limited knowledge of osteoporosis among the studied female students may stem from a general lack of awareness about the disease and its prevention. Their knowledge improved following the implementation of the program due to active engagement in structured learning. Furthermore, interactive learning strategies, such as discussions, facilitated cognitive processing and enhanced memory retention, reinforcing their knowledge acquisition.

Results of the existing study presented that, a statistically significant difference ($p \leq 0.05$) was observed in most items of the Osteoporosis Health Belief Scale (OHBS) after the program's implementation. The mean scores showed improvements in perceived susceptibility, perceived seriousness, barriers to exercise, barriers to calcium intake, and barriers to vitamin D intake. Additionally, higher scores were noted for the perceived benefits of exercise, calcium intake, vitamin D intake, and health motivation. These findings may suggest that most of the studied female students recognize the significant impact of osteoporosis on their health. The increased mean scores indicate an improved understanding of the benefits of exercise, calcium intake, and vitamin D consumption.

These results corresponded with the study conducted in Turkey by Pinar & Pinar (2020), titled "The impact of health belief model based educational intervention on women's knowledge, beliefs, preventive behaviors and clinical outcomes about osteoporosis" The study reported a significant increase in knowledge and health belief scores in the intervention group ($p < 0.05$).

Similarly, a study executed in Qazvin, Iran by ***Panahi et al. (2021)*** titled "Promoting the adoption of behaviors to prevent osteoporosis using the health belief model integrated with health literacy: quasi-experimental intervention study" documented significant improvements after the educational intervention. An increase in the average score for perceived benefits and a decrease in perceived barriers were noted within the intervention group. These outcomes were statistically significant, demonstrating clear distinctions between the intervention and control groups.

Contrary to the results of this study, the study by ***Peksoy-Kaya, Kaplan, and Başkaya (2024)*** titled "A survey of the effect of an information-motivation-behavioral model-based intervention on university students' osteoporosis knowledge, health beliefs, and self-

efficacy" in Turkey determined that no statistically significant differences were observed between the pretest and follow-up scores on both the Osteoporosis Health Belief Scale and the Osteoporosis Self-Efficacy Scale ($p > .05$).

The improvement in Osteoporosis Health Belief Scale scores observed after the implementation of osteoporosis prevention programs could be attributed to enhanced knowledge about the condition, increased awareness of personal susceptibility and disease severity, a clearer understanding of the benefits of preventive behaviors, and a reduction in perceived barriers to adopting such behaviors. These changes align with the Health Belief Model framework, which posits that modifying these beliefs increases the likelihood of adopting preventive health behaviors ***(Panahi et al., 2021).***

Regarding female students' osteoporosis self-efficacy, the present study demonstrated a moderate overall effect of the program on improving osteoporosis-related self-efficacy. The observed increase revealed a statistically significant difference ($p \leq .05$).

In the same vein, the study titled "Self-efficacy of osteoporosis preventive behaviors and its predictors in Iranian adolescents" by ***Ghelichkhani, Mirghafourvand, Bahrami-Vazir, Vali, and Mohammadi (2021)*** reported findings suggesting most of the students possessed a moderate level of knowledge and self-efficacy concerning osteoporosis preventive behaviors.

The results of the ***Peksoy-Kaya et al. (2024)*** study differed from the results established in this study; they reported that their intervention did not improve participants' self-efficacy in performing weight-bearing exercises, taking calcium, and engaging in physical activity.

The moderate improvement in self-efficacy scores after the osteoporosis prevention program may be due to multiple factors such as the complexity of changing several health behaviors simultaneously; adolescents' perception of osteoporosis as a distant concern; persistent practical barriers to maintaining preventive behaviors; and the developmental stage of adolescents regarding self-efficacy formation. Despite being moderate, the improvement was statistically significant, confirming the program had a meaningful positive impact.

The current study results discovered a highly statistically significant ($p < .001$) in the osteoporosis preventive behaviors (OPBS) of the studied female students after the implementation of the program.

In the similar context, the study by ***Panahi et al. (2021)*** titled "Promoting the adoption of behaviors to prevent osteoporosis using the health belief model integrated with health literacy: quasi-experimental intervention study" found that the intervention group showed a significant increase in mean scores for osteoporosis-related preventive behaviors following the intervention.

The study titled "Promotion of osteoporosis-preventive behaviors in adolescents: Application of protection motivation theory" by ***Khazaeian et al. (2021)*** also supports the results of this study. They mentioned that post-intervention period, a significant difference was detected between the groups regarding their preventive behaviors (specifically calcium consumption, exercise habits, and sun exposure) compared with the pre-intervention (P = 0.001). This suggests a higher likelihood among female students to participate in behaviors conducive to osteoporosis prevention, encompassing nutritional adequacy, physical activity, and lifestyle optimization.

Better health beliefs and knowledge are likely to have higher self-efficacy regarding osteoporosis prevention. Furthermore, higher knowledge and self-efficacy are associated with better osteoporosis preventive behaviors ***(Armstrong, 2021).*** Therefore, the current study illustrated that a strong-positive correlation is evident between HBS and self-efficacy ($r = 0.400$, $p < 0.001$) and a moderate-correlation between knowledge and self-efficacy ($r = 0.375$, $p < 0.001$). Also, a moderate positive correlation exists between OPBS and knowledge ($r = 0.259$, $p < 0.001$) and OPBS and self-efficacy ($r = 0.369$, $p < 0.001$).

In alignment with the current study's results, the study by ***Althobiti et al., (2020)*** titled "Knowledge, Beliefs and Preventive Behaviours Regarding Osteoporosis Among Female Health Colleges' Students at King Abdulaziz University" reported that a statistically significant positive correlation was observed between students' osteoporosis knowledge and their health beliefs.

The finding of the existing study is consistent with a study titled "Gender Disparities in Osteoporosis Knowledge, Health Beliefs and Preventive Behaviors" conducted in Najran City, Saudi Arabia by ***Ibrahim, Nahari, Al-Khadher, Ismail, and Elgzar (2023).*** Statistically positive correlations ($p < 0.001$) were found between OPB and various factors, including osteoporosis knowledge ($r = 0.26$), perceived susceptibility ($r = 0.33$), perceived severity ($r = 0.53$), perceived benefits of exercise ($r = 0.54$) and calcium intake (r

= 0.33), perceived barriers to exercise (r = 0.40) and calcium intake (r = 0.81), as well as health motivation (r = 0.37).

Conclusion

In deduction, based on the findings of the current study and its hypotheses, there was a statistically-significant difference in knowledge, health beliefs, self-efficacy, and behaviors regarding osteoporosis among female students pre- and post-participation in the interactive online preventive program.

Recommendation

Based on the results of the present study, the following recommendation is proposed:

- Continue and regularly update the interactive osteoporosis prevention program to reinforce knowledge and sustain healthy behaviors among students.
- Establish a structured, continuous prevention program each academic year to ensure long-term engagement and impact on students' health beliefs and practices.
- Create interactive mobile applications for students to track calcium intake, vitamin D levels, and weight-bearing exercise activities.
- Implement bone health campaigns with regular screening opportunities, particularly targeting female students who face higher risk factors.
- Develop specialized programs for students with family history of osteoporosis, eating disorders, or amenorrhea.

Conflict of interest:

The authors confirm no conflicts of interest related to this study.

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