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Nutrition Intervention Based on Health Belief Model for Promoting Dietary Calcium Intake among Adolescent Girl students

Amal A. El-Abbassy [1*], Afaf Abel Malek Hussein [2],Hanaa. M Ahmed[3], Samar Salah Eldin Mohamed Diab[4], Samia Ali El-Nagar[5]

[12&5]Family and Community Health Nursing, Faculty of Nursing, Menoufia University, Egypt

[3&4]Pediatric Nursing, Faculty of Nursing, Menoufia University, Egypt

ABSTRACT

Adolescents are a unique target group as optimal growth during this period is considered to be of main importance in maintaining good health thereafter. Calcium deficiency in early adolescence is one of the most common reported nutritional problems globally. **Aim:** To examine the effectiveness of nutrition intervention based on health belief model for promoting dietary calcium intake among adolescent girl students. **Methods:** Design: A quasi-experimental (study and control group) design. **Subjects**: Simple random sampling composed of 200 adolescent girl students aged 12-15 years. **Setting**: This study was conducted at four preparatory schools from rural and urban schools in Shebin El-Kom and El-Shohadaa districts at Menoufia Governorate, Egypt. **Instruments**: 1. A structured interview questionnaire that comprises socio-demographic data and environmental data about dietary calcium intake.2. Students' knowledge questionnaire related dietary calcium intake. 3. Students' practice habits questionnaire related dietary calcium intake. 4. Health belief model construct questionnaire related to dietary calcium intake. 5.Calcium rich food frequency questionnaire. **Results:** The findings of this study revealed a significant improvement in adolescent girls' awareness, and practice level related to dietary calcium intake in the study group as compared to the control group. Moreover, there was a significant increase in the mean total of dietary daily calcium consumption (mg) in the study group (1231.04±221.01) compared to 904.47±183.38 in the controls group. Besides, HBM structures mean score were significant higher including perceived benefits of calcium-rich foods consumption, susceptibility to the occurrence of diseases, risk resulting from the deficiency of calcium intake, and self-efficacy, while found a significant decrease in barriers to obtaining enough calcium in the study group compared to control group. **Conclusion:** Nutrition intervention based on HBM had a positive effect on promoting adolescent girls' awareness, and practice habits related to dietary calcium intake as well as promoting dietary daily calcium consumption. **Recommendations:** The need for establishing nutrition interventions based on HBM in schools to promote adolescent girls' calcium intakes, as well as emphasizing on parents and providing recommendations for enhancing calcium-rich food availability at home.

Keywords: Adolescent Girl students, Dietary calcium intake, Health Belief Model, Nutrition intervention.

Introduction:

Adolescents are considered to be a unique target group as optimal growth during this period is considered to be of prime importance in maintaining good health thereafter. Adolescence is the transformation from childhood to adolescence creates special nutritional needs for growth and development that have to be provided through proper eating habits and dietary pattern (Geckle, 2016). According to the World Health Organization (WHO) adolescents identified as those between the ages of 10 and 19, characterized through a rapid period of growth and development, throughout which nutrition and micronutrient requirements are extremely high (WHO,

2018).Also, it is a crucial time of biological and psychosocial growth and development that is distinct from other stages of life. Adolescents' nutritional requirements are more than prepubescent children and adults (Bhutta et al., 2017).

According to the United Nations, adolescents aged 10 to19 accounting for 16 percent of the world's population today. Most teenagers are protected by the protocol on the rights of the children before they reach the age of 18. Despite this, their weaknesses and requirements are often overlooked (UNICEF, 2020). In Egypt, there are around 19 million girls under the age of twenty, accounting for one-fifth of the population. Around 8 million from these females were between the ages of 10 and 19 in 2015.According to the United Nations Population Division's most current estimations, this group will expand to 11.5 million in 2030, representing 44 percent rise in 15 years (Roudi-Fahimi, 2016).

Calcium and vitamin D are the key nutritional players in the formation and maintenance of bone structure and density. Sufficient consumption of calcium is a critical factor in achieving, maintaining bone strength, and preventing fractures. Calcium is vital nutrient for bone health because it leads to bone strength (Rouf, Nour & Allman-Farinelli ,2020). It is also crucial for proper skeletal and tooth growth and development. Furthermore, calcium is vital for blood clotting and maintaining the physiological condition of the body's cells. More than 99 percent of the total body calcium is detected in teeth and bones, where this provides strength to hard tissue. Sufficient calcium intake throughout adolescent years is critical for optimizing bone mass and decreasing the risk of osteoporosis in later life (Sumath & Karam, 2018).

One of the most significant nutritional dangers in adolescence is poor eating habits, such as skipping meals, eating lots of fast foods, as well as following fad diets. These habits encourage insufficient calcium intake and, as a result, growth retardation in children and adolescents (Bouzianiet et al., 2018)_Calcium is found in a variety of foods, but milk and dairy products, such as yoghurt, cheeses, and buttermilk, are the greatest sources of calcium (1150 mg/l) that is more accessible and easily absorbed in the body (Bouziani et al., 2018). Furthermore, calcium can also be found in some green leafy vegetables like broccoli, spinach, parsley, lettuce, as well as cabbage are favorable to other vegetables, and fishes such as herring, canned salmon, besides sardines are high in calcium. Additionally, roasted soybeans, baked beans, as well as dried figs contain calcium (Ghajari et al., 2016). The recommendations for calcium intake vary around the world based on age, sex, and other environmental influences. The recommended dietary daily allowance of calcium for boys and girls aged 9 to 18 is 1300 mg daily (Nguyen, 2021).

Research studies clearly demonstrated that calcium level in adolescents is very low, so a large percentage of this group has insufficient calcium intake, which is mostly due to a lack consumption of calcium-rich foods, particularly dairy products (Bouziani et al., 2018; Lee et al., 2018). Thus, it is necessary to pay special attention to aged 9–18 years whose increased requirements particularly dairy products, are not met through recent consumption habits. As a result, effective strategies are necessary to improve the calcium intake as adolescent awareness and nutritional education, thus decrease calcium insufficiency problems that affect the entire body throughout adolescent years (Bouziani et al., 2018).

As a key strategy to sustain and enhance health during this crucial time of life, there is a strong focus on promoting good nutrition behavior during childhood

as well as adolescence through successful education. Establishment of well lifestyle practices must be started from early especially the young adult age because most of them become self-centered and are not concerned in healthy life and it is not easy to change their behavior and lifestyle . Programs based on health belief model (HBM) are effective and inexpensive method for enhancing the knowledge and practices that required for establishing behavioral changes such as increasing consumption of calcium and physical activities for prevention of osteoporosis. It is built on the idea that individuals are willing to maintain wellbeing through following health-related action to avoid an undesirable health condition (Ali, Mekhamier & El Sayed, 2020).

Health education intervention is among the most effective ways of preventing diseases and promoting health. The use of frameworks such as HBM has an important effect on achieving these objectives (Mousaviasl et al., 2016).The HBM is one of the approaches that can be used to help to understand health - related behaviors, and using it to enhance the efficacy of nutritional education programs is highly recommended. The most essential characteristic of this model is that it assists individuals in making the best health choices among the options available to them, including good or poor dietary patterns .The components of this approach are perceived susceptibility, severity, benefits, barriers, self-efficacy as well as cues of action (Salama et al., 2020).

Health belief model based nutrition education improved students' health literacy and nutritional behaviors (Vahedian et al., 2019). Numerous researches have revealed that, this approach is effective in promoting healthy behavior. According to a study conducted in Egypt by Salem and Said (2018) to assess the effect of HBM-based nutrition education on the secondary school adolescent females' food patterns in Egypt's Sharkia governorate. They concluded that, teaching built on HBM improved not just teenage females' nutritional knowledge, but also helped them put part of it into practice. Moreover, research study in Iran by Naghashpour et al (2014) found that nutrition education based on HBM improved nutrition awareness, attitude, and behavior in high school girl students who received dietary calcium. In line with Keshani et al (2019) who examined the effect of HBM on improving diet quality among adolescents, showed that the experimental group's HBM structures and knowledge had greatly improved, and mean differences had increased following the intervention. The experimental group's diet quality increased, which was significantly different from the comparison group. Moreover, a study performed by Mousaviasl et al (2016) to assess the impact of using HBM's on osteoporosis prevention among female high school students. The study result indicated that after the intervention, there were substantial statistical differences in mean knowledge scores between the experimental and control groups, HBM's constructs, and preventive behaviors. Also, a health education program based on the HBM showed to be more effective than typical didactic health education in raising daily calcium intake.

Girls are more crucial than boys when it comes to nutrition education with the goal of better nutrition behaviors because they are the mothers of tomorrow and several of the dietary ideas that they know and understand will influence not only for their own health but also the health of their children and family in the future. As a result, teaching is critical in enhancing this group's nutrition knowledge and awareness. The nutritional status of adolescent girls, who will become future mothers, has a significant impact on the community's nutritional status. Adolescent girls have

only recently been included as participants in certain health and nutrition intervention strategies (Meenakshi &Hajistha, 2019). According to Ghajari et al (2016) revealed that intervention programs should focus on improving female students' knowledge and practices about calcium-rich foods in order to enhance their intake. Calcium deficiency has negative consequences; if it is not prevented in students, it will result in bone loss and fractures in later life (Panahi, 2020) As a result, the present study aimed to examine the effectiveness of nutrition intervention based on HBM for promoting dietary calcium intake among adolescent girl students.

Aim of the Study

The present study aimed to examine the effectiveness of nutrition intervention based on health belief model for promoting dietary calcium intake among adolescent girl students.

Research hypotheses

1. The knowledge level and mean total score about dietary calcium intake among the study group will be improved after receiving the nutritional educational intervention based on HBM compared to the control group.
2. Students' practice level concerning dietary calcium intake will be improved in the study group after receiving the nutritional intervention based on HBM compared to control group.
3. The mean total of dietary calcium intake (mg/day) will be higher after receiving the nutrition intervention based on HBM in the study group than the control group.
4. The study group will have higher mean total score of perceived susceptibility to disease, severity from deficiency of dietary calcium intake, benefits of dietary calcium consumption and self-efficacy while will have lower mean total score of perceived barriers after the nutrition intervention based on HBM than the control group.

Subjects and methods

Research design: A quasi-experimental (study and control group) design.

Setting: This study was conducted at four preparatory schools from rural and urban schools in Shebin El-Kom and El-Shohadaa districts at Menoufia Governorate, Egypt. Multistage random sampling technique was used for the selecting the four schools to implement the study.

Subjects: Simple random sampling composed of 200 adolescent girl students aged 12-15 years. Multistage random sampling was used in this study for random choice of districts, villages, schools, and students to obtain the representative sample to the total study population.

Sampling technique:

- First stage; random sample was used to pick two districts from nine at Menoufia Governorate. Districts' names were placed in a bowl and picked two districts by simple random sample (Shebin El-Kom district and El-Shohadaa district).
- Second stage; a simple random sample was used to choose two villages, one from the Shebin El-Kom district and the other from the El-Shohadaa district. The villages' names in the two districts were listed and placed in a container, after which a simple random sample was used to choose two villages. The selected villages were Kafer Tanbady village from Shebin El-Kom district and Kafer Ashma village from El-Shohadaa district.
- Third stage; a simple random sample was used to select four preparatory schools (two from urban and two from rural communities). A simple random

sample technique was used for the choosing of four schools to implement the study; from Shebin El-Kom's preparatory schools namely El-Massay preparatory school for girls, Kafer Tanbady preparatory school. The preparatory schools selected from El-Shohadaa namely El-Shohadaa preparatory school for girls and Kafer Ashma preparatory school.

- Fourth stage; random sample was used to select students. Students' names were identified and put them in a container, then select students in every class by simple random sample, until the sample size reached 200 students.
- Fifth stage; the whole sample of girl students was allocated at random into study group (100) and control group (100).

Sample Size and power of the study:-

The researcher utilized the Epi statistical tool from the Open Source Statistics for Public Health to compute the required sample size. The assumptions were: a two sided confidence level of 95% = (1- α); a power (1- β) or (% chance of detecting) of 80%; ratio of sample size, unexposed (control)/ exposed (study group) = 1% of unexposed with outcome (dietary calcium intake) = 20%; Then the researchers entered one of two parameters which was the least extreme Odds Ratio (3) to be detected, and the other parameter would be calculated by the Epi website program. The researchers used Epi website program and results were presented using methods of Kelsey et al (2010). The researcher used Fleis with correction method with 83 adolescent girls with as our study group, and another 83 adolescent girls as control, with a total sample size of 166 adolescent girls. In order to safe guard against reluctance of some adolescent girls in the follow up visits, we approximate the sample size to100 in each group, with a total sample size of 200 adolescent girls.

Tools of Data Collection: Five instruments were utilized to accomplish the current study's aim:

Tool (1) A structured interview questionnaire*:* this questionnaire was designed by the researchers after the scientific literature review to assess:

A. Socio demographic data such as school name, age, academic year, residency, father's and mother's educational level, father's and mother's occupation, having bigger sisters, and having friends.

B. Environmental data about dietary calcium intake: as pre-test: - It was developed to evaluate availability of calcium rich foods at home and parents as well as peers encouragements. Availability of calcium rich foods was tested by eight questions such as availability of milk, yogurt, cheese, fruits (orange, dates and figs), vegetables, fish/fish products, chicken and eggs; legumes (beans & lentils) and grains. Encouragements was assessed by two questions as parents and peers encouragement to drink milk and eat dairy products. The adolescent girl students' responses about environmental data in three points Likert scale 1 -3, where one indicated no, two indicated sometimes, and three indicated always. The tool's reliability was done using test-retest reliability and proved to be reliable; Cronbach's alpha for the environmental factors was determined as $\alpha = 0.85$ which suggested a high internal consistency of environmental factors part of the instrument. Data collected by the researchers at the initial data collection point.

Tool (2)Students' knowledge questionnaire related dietary calcium intake *(*pre-post test):

It was developed by the researchers to evaluate the student's knowledge about dietary calcium. It was tested by fifteen questions including health benefits of

calcium, crucial phase of calcium absorption and bone growth, calcium deficiency health risk as osteoporosis, sources of calcium rich foods and the recommended daily requirement of calcium for adolescents etc.,. Each question's response is in the form of yes, no or don't know. The results were categorized as wrong answer/don't know (0) and correct answer (1). The student's total knowledge score about dietary calcium ranged from 0-15. The total score of each student was categorized into "poor knowledge" when achieved 0-8 of the total score, and "good knowledge" was considered when achieved 9-15 of the total score. The tool's reliability was done using test-retest reliability and proved to be reliable; Cronbach's alpha was 0.87, indicating that this tool is reliable in detecting the study's objectives.

Tool (3) Students' practice habits questionnaire related dietary calcium intake *(pre-post test):*

It was developed by the researchers to assess the student's dietary practice habits is related to calcium intake. It was tested by ten questions such as "number of times have you checked the nutrition label on food cans whereas shopping", "parents give you milk to drink at dinner most nights", drinking milk, eating salmon, eating pudding, eating green vegetables, drinking chocolate milk and exposing body to sun's rays in the morning. Each question's response is in the form of three point likert scale never (0), sometimes (1) and always (2).Students were categorized into "poor practice" when she had from ≤10 points of the total score, and "good practice" when she had ≥ 10 points of the total score. The tool's reliability was done using test-retest reliability and proved to be reliable; a Cronbach's alpha for the students' practice about dietary calcium intake determined as $\alpha = 0.78$ which suggested a good internal consistency of the tool.

Tool (4) Health belief model constructs questionnaire related to dietary calcium intake *(pre-post test):*

It was developed by the researchers following a review of the relevant literature and used for assessing the student's perception related to dietary calcium intake. HBM constructs questionnaire involved 48 items: perceived benefits from adequate calcium consumption include improvement of musculoskeletal strength and protection of low back pain and obesity (14 items); perceived susceptibility that are at risk of developing calcium insufficiency problems when consume insufficient amounts of dietary calcium. (9 items); perceived severity and possible consequences of inadequate intake of dietary calcium as bone fractures, and osteoporosis (7 Items);perceived barriers includes obstacles to getting enough calcium e.g. high expense and unavailability of dairy products (10 items); and self-efficacy (8 items). The student response for each item with two Likert scale 1-2, where one indicated disagree, and two indicated agree. The tool's reliability was done using test-retest reliability and proved to be reliable; a Cronbach alpha for HBM construct questionnaire related to dietary calcium intake was $\alpha = 0.86$. All the five constructs of the model also have high internal consistency with perceived benefits, $\alpha = 0.81$; perceived susceptibility, = 0.89; perceived severity, $\alpha = 0.83$; perceived barriers, $\alpha = 0.84$, and self-efficacy, $\alpha = 0.87$.

Tool (5) Calcium rich food frequency questionnaire *(pre-post test):*

The daily calcium intake was estimated by using calcium rich food frequency questionnaire that was designed by the researchers following a review of relevant the literature. The FFQ was comprised of easily accessible foods such as milk as well as dairy products (milk, yoghurt and cheese); meat, fish/fish products, chicken and eggs; legumes (beans & lentils)

and grains; vegetables (cabbage, okra, and spinach) and fruits (dates, figs and oranges) etc. Adolescents' girl students were asked to choose the types and number of serving sizes of each food that they consume on a usual week day from a list of calcium-containing rich foods. To estimate approximately daily calcium intake (mg), this information on dietary calcium intake for each student was entered into calcium calculator Link (http://www.webmd.com/diet/ calcium-food-calculator/default.htm). Recommended dietary daily allowance of calcium for girls aged 9 to 18 is 1300 mg daily, according to Dietary Reference Intakes established by the Food and Nutrition Board of the National Institutes of Medicine (**Institute of Medicine, 2011**). The tool's reliability was done using test-retest reliability and proved to be reliable; Cronbach's alpha was determined as $\alpha = 0.87$ which indicated a high internal consistency of this instrument.

Validity of the tools: It was tested for its validity by group of 5_experts (four Professors in pediatric nursing, pediatric medicine, nutritionist and one expert in family and community health nursing).

Pilot Study: It was carried out to assess the questionnaire's usability and applicability, as well as to identify any potential concerns that might arise during data collection. Also, to guess how long it would take to complete the questionnaire. A total of 20 students participated in the pilot study. Students who participated in the pilot study were not involved in the total sample.

Ethical consideration:

The Ethical Committee for Scientific Research Review, Faculty of Nursing, Menoufia University, Egypt approved the proposal. Also, the agreements for participation of the subjects were taken after the study's aim was explained to them. Before data collection, the students were informed about the study's aim and what would be done with the results. They were given the option of declining to participate and they could withdraw at any stage of the research. Also, they were told that the details would be kept confidential and used for the research purpose only. The researcher gave copies from the nutrition intervention booklet to the control group after the intervention time is ended. Also, the researcher gave copies from the nutrition intervention booklet to the study group for achieving the ethical principles of research as well as the principle of beneficence.

Procedure of data collection

- The data collection phase was achieved between 1st of October 2018 to the end of April 2019.
- A reviewing of past and current literature covering the problem's various aspects was done using books, journal articles, besides studies concerning promoting dietary calcium intake.
- An official letters were issued from Faculty of Nursing, Menoufia University, Egypt, and sent to directors of the included schools after explanation of the study's aim to get their permission for data collection from the authorized personal.
- Before starting the data collection, the agreements and the study's aim were explained to each director of school and school's teachers to gain their cooperation.
- After selection of the study subjects, the study's aim was explained to each group, and then a pre-test was conducted for both groups.
- Pre-test questionnaire included socio demographic characteristics, environmental data, students' knowledge and practice related to dietary calcium intake, HBM constructs about dietary calcium intake questionnaire and calcium rich food

frequency questionnaire. The average time taken about 15-25 minutes.

- Pre-test data were analyzed, and as a consequence of the findings, a nutritional intervention based on HBM was designed for the study group.
- The nutrition intervention's contents consisted of a variety of concise, obvious, as well as understandable data and activities aimed at enhancing calcium intake. The following issues were covered in these contents including: food guide pyramid and dietary daily requirements for adolescent girls, health benefits of dietary calcium intake for the body, risk of developing calcium deficiency complications, calcium rich food sources, recommended dietary calcium allowance for adolescent girls, factors that promote and reduce calcium absorption in the gastrointestinal tract, vitamin D role in calcium absorption, and main sources of vitamin D. Following the implementation of the nutrition intervention, each student received a brief booklet of the taught material.
- Adolescent girl students were divided into groups and every group comprised 10-15 students.
- The researchers used a variety of teaching materials and techniques in the implementation of the nutritional intervention to increase dietary calcium intake, including lecture, group discussion, as well as demonstration. To improve student learning, a PowerPoint presentation was combined with videos as well as posters and education instruction booklet.
- The control group received no interventions during this period.
- Two months after the last session, a post-test was performed on both the control and study groups for final evaluation to determine the resulting behavioral changes.

Implementation of nutrition intervention based on HBM

- The researchers used HBM constructs to predict and enhance change students' health beliefs regarding adequate calcium intake behavior; using the five variables of model as reviewed from previous studies. As perception about the seriousness of not taking calcium, susceptibility to consequences related to inadequate dietary calcium consumption such as bone fractures and osteoporosis later, the benefit of enough dietary calcium intake, the barriers of not taking calcium, motivation to promote health, and confidence in her ability to take calcium.
- The nutritional intervention booklet was developed by the researchers and reviewed by a group of five experts in of fields of pediatric nursing, pediatric medicine, Nutritionist and one expert in community health nursing, and written in Arabic word office and printed out according to the sample size with additional copies. Then, the researchers explained nutritional intervention booklet about importance of adequate calcium intake and asked questions for encouragement of adequate calcium intake.
- The researcher argued along similar lines for problems associated with interpreting the perceived severity and benefits/barriers constructs. It was taken about 60 minutes.

Perceived susceptibility: At first, students are not currently adopting healthy behavior related to adequate calcium intake behavior, but considering the prospect of adopting healthy behavior. When participants realized susceptibility, the positive aspects of their condition start to outweigh the negative aspects of not

practicing adequate calcium intake behavior. There was recognition of a problem; the students perceived as associated with optimal behaviors for adequate calcium intake behavior. The goal of intervention when individuals realized susceptibility was to increase the person's likelihood of steps to adopt healthy behaviors related to adequate calcium intake behavior. Therefore, the materials focused on maximizing healthy behaviors, increasing awareness, gathering more information, and creating a new practice as healthy behaviors related to adequate calcium intake behavior.

Perceived seriousness: The researcher simply asked the students about the seriousness of not practicing adequate calcium intake behavior. For example "what is the seriousness of not practicing adequate calcium intake behavior on health?" The researcher started by asking about the negative aspects of their behavior to reduce the amount of resistance and motivate participants to subsequently talk about the positive aspects of their behavior. Once the participant finished talking about the negative aspects of not practicing adequate calcium intake behavior, the researcher briefly summarized what had been discussed. The student was then encouraged to talk about the positive aspects of practicing adequate calcium intake behavior.

Perceived benefits: The researcher encouraged participants to elaborate on the more positive aspects of practicing adequate calcium intake behavior appropriately by asking questions such as "How does sufficient calcium intake behavior affect you?". Simply by allowing the participants to talk about their willingness and their need to positive behaviors, the researcher was facilitating these positive behaviors. The researcher briefly summarized the positive and the negative aspects of practicing adequate calcium consumption behavior. Once the student finished talking about the positive aspects of benefits of practicing adequate calcium intake behavior through taking food rich in calcium, vitamin D and exposure to sunlight, the researcher briefly summarized what had been discussed.

Perceived barriers: This construct considers a student's perception of the influences that facilitate or discourage the adoption of the promoted behavior. The negative attributes of health behavior factor that students think negatively will affect her when practicing adequate calcium intake behavior. This dimension includes factors such as perceived consequences related to taking food rich in calcium such as eating calcium-rich foods require special change of her dietary habits which is difficult, eat calcium-rich foods not suite her, calcium rich foods are too expensive and drinking milk will cause her overweight. All of these potential calcium intake behavior disadvantages have been found to inhibit adequate calcium intake behavior. The student was encouraged in order to tackle these obstacles of their practices of adequate calcium intake behavior. The researcher succinctly summarized the positive and the negative aspects of the student's practicing of adequate calcium intake behavior. The psychological discomfort created by contrasting the individual's behavior with her attitude was one of the motivators that help participants to practice adequate calcium intake behavior.

Taking healthy behavior and self-efficacy: The students were ready for practicing adequate calcium intake behavior. The researcher provided practical advice on how to go to health motivation and decision making to change and continue to boost her motivation to change. The researcher's task was to help the students determine the best course of action to be taken in order to change their inadequate calcium intake

practices. HBM advocates the replacement of any inadequate behavior with more adequate activities. The researcher encouraged each student to improve adequate calcium intake practices. The goal of an intervention was to increase their adoption of healthy behaviors related to practices of adequate calcium intake behavior. At the end of the session, students received personalized, developed nutrition booklet. Evaluation was applied by comparing knowledge and the practices of adequate calcium intake behavior before and after intervention.

- Two months after the last session, a post-test was performed on both the control and study groups. Post-test questionnaire was used for assessing the effect of the nutrition intervention based on HBM on adolescent girls' knowledge and practice about dietary calcium intake as well as dietary daily calcium intake. It was taken about 15-25 minutes.

Statistical analysis

Data was entered and analyzed by using SPSS (Statistical Package for Social Science) statistical package version 22. Quantitative data were presented by mean (X) and standard deviation (SD). It was analyzed using student t- test for comparison between two means, and ANOVA (F) test for comparison between more than two means. Qualitative data were presented in the form of frequency distribution tables, number and percentage. It was analyzed by chi-square (χ^2) test. However, if an expected value of any cell in the table was less than 5, Fisher Exact test was used(if the table was 4 cells) , or Likelihood Ratio (LR) test (if the table was more than 4 cells). Level of significance was set as P value <0.05 for all significant tests.

RESULTS

Table 1:shows that the mean age of study group of adolescent girl students' was 13.42± 0.59 compared to 13.35±0.63 among the control group with non-significant statistical differences between study and control groups regarding each item in socio-demographic characters (P>0.05 for each).

Table 2: represents distribution of the studied adolescent girl students' according to their environmental factors related dietary calcium intake. It shows no statistically significant difference was found between study & control group as regards to all environmental factors included availability of calcium rich food at home as milk, yogurt, cheese, fruits (orange, dates and figs), vegetables, meat, fish/fish products, chicken and eggs; legumes (beans & lentils) and grains as well as of parents and peers encouragements to drink milk and eat dairy products (P>0.05).

Tables 3: Support hypothesis (1) which stated that mean total score of knowledge about dietary calcium intake among the study group will be higher after the implementation of nutrition intervention based on HBM than the control group. It reveals that at post intervention, there was a highly significant improvement in the different items of knowledge about dietary calcium intake among the study group compared to the control group (p<0.0001). In addition, comparing mean total post intervention knowledge score between study and control groups reveals a higher mean score among study group comparing to control group (11.8 ± 2.6 vr 3.6 ±. 1.5) and the difference was high significant statistically (P<0.0001).

Figure 1: Supported hypothesis (1)that reported that the knowledge level about dietary calcium intake among the study group will be improved after the implementation of nutrition intervention based on

HBM compared to the control group. It illustrates that at the pre intervention, most of the study group (83%) and control group (88%) had poor knowledge level about dietary calcium intake with no statistically significant difference. In comparison to post intervention, the good knowledge level among study group were increased (87%) versus control group (10%) and the difference was statistically significant (P<0.0001).

Fig.2: Support hypothesis (2) which mentioned that the practice level related to dietary calcium intake among the study group will be improved after the implementation of nutrition intervention based on HBM compared to the control group. It illustrates that at the pre intervention, most of the study group (87%) and control group (89%) had poor practice level related to dietary calcium intake with no statistically significant difference compared to post intervention, the good practice level among study group were increased (75%) versus control group (15%) and the difference was statistically significant (P<0.0001).

Table 4: Support hypothesis (3) proposed that the mean total of dietary calcium intake (mg/day) will be higher in the study group after the nutrition intervention based on HBM than the control group. This table reveals that at the pre intervention, no statistically significant difference in the mean total of dietary calcium intake (mg/day) among study group (1036.49±164.4) and control group (901.86±188.35).This result shows that the average of dietary calcium consumption per day is less than the recommended dietary daily requirement of calcium for adolescent girls among the studied groups. In comparison to post intervention, there was a highly statistically significant improvement in the mean total of dietary calcium intake (mg/day) among study group (1231.04±221.01)compared to 904.47±183.38 among control group (P <0.0001).

Table 5: Support hypothesis (4) which mentioned that the study group will have higher mean total score of perceived susceptibility to disease, severity from deficiency of dietary calcium intake, benefits of dietary calcium consumption and self-efficacy while will have lower mean total score of perceived barriers after the nutrition intervention based on HBM than the control group. It shows that at post intervention among the study group, there was a highly significant increase in mean total score about each of perceived benefits of calcium-rich foods consumption, susceptibility to the occurrence of diseases resulting from calcium deficiency, risk resulting from a deficiency of calcium intake, and self-efficacy while there was significant decrease in barriers to obtaining enough calcium, compared to the control group (P<0.0001 for each).. Among study group, the mean grand total score of adolescent girl students before intervention was 69.21 ± 3.5 which was increased post intervention to 79.93 ± 3.5 and the difference was highly statistical significant (P<0.0001). In addition, comparing mean total post intervention grand total score between the study and control groups reveals a higher mean score among the study group comparing to control group (79.93 ± 3.5 vr 65.66 ±. 3.2 and the difference was high significant statistically (P<0.0001).

Table 1: Distribution of Socio-demographic Characteristics of The Studied Groups (N = 200)

Socio demographic characters	Studied groups	Study group (N=100)		Control group (N=100)		P value
		No.	%	No.	%	
Age (years)	12-13 Y	44	44.0	53	53.0	X^2=1.6, P=0.20
	14 – 15 Y	56	56.0	47	47.0	
	Mean ±SD	13.42± 0.59		13.35±0.63		t = 0.67, p=0.50
Academic year	First	52	52.0	51	51.0	X^2 =0.0, P=0.89
	Second	48	48.0	49	49.0	

Socio demographic characters	Studied groups	Study group (N=100)		Control group (N=100)		P value
		No.	%	No.	%	
Child rank in the family	1st – 2nd	64	64.0	67	67.0	X2=0.02, P=0.88
	3rd - 4th	36	36.0	33	33.0	
Father's education	Low	19	19.0	14	14.0	X2=2.4, P=0.67
	Moderate	43	43.0	38	38.0	
	High	38	38.0	48	48.0	
Father's occupation	No work	3	3.0	2	2.0	LR=8.1, P=0.15
	Worker	11	11.0	15	15.0	
	Farmer	8	8.0	17	17.0	
	Employee	54	54.0	54	54.0	
	Entrepreneur	24	24	12	12	
Mother's education	Low	19	19.0	23	23.0	X2=0.78, P= 0.37
	Moderate	45	45.0	37	37.0	
	High	36	36.0	40	40.0	
Mother's occupation	Housewives	62	62.0	69	69.0	X2=0.54, P=0.46.
	Farmer/Workers	4	4.0	6	6.0	
	Employees	34	34.0	25	25.0	
Total		100	100	100	100	

Table 2: Distribution of The Studied Adolescent Girl students According to Their Environmental Factors towards Dietary Calcium Intake (N = 200)

Environmental factors towards calcium intake	Pre intervention		
	Study group (100)	Control group (100)	P Value
	Mean ± SD	Mean ± SD	
Availability of calcium rich foods at home including:			
Milk	1.44±0.83	1.28±0.68	0.14
Yogurt	1.45±0.66	1.36±0.51	0.23
Fruits (orange, dates and figs)	1.51±0.59	1.47±0.60	0.17
Cheese	1.18±0.44	1.27±0.78	0.62
Legumes (beans & lentils) and grains	2.69±0.60	2.53±0.95	0.64
Vegetables	1.34±0.55	1.45±0.91	0.75
Fish and fish products	1.16±0.42	1.08±0.42	0.17
Eggs	1.17±0.42	1.18±0.42	0.15
Encouragement for drinking milk, and eating dairy products			
Peers' encouragement	1.06±0.31	1.02±0.20	0.28
Parents' encouragement	1.38±0.97	1.26±0.68	0.08

Table 3: Percent Distribution of Adolescent Girl Students' knowledge about Dietary Calcium Intake among the Studied Groups Pre and Post Intervention (N = 200)

Students' knowledge about Dietary Calcium Intake	Pre intervention				P value	Post intervention				P value
	Study group		Control group			Study group		Control group		
	Wrong	Correct	Wrong	Correct		Wrong	Correct	Wrong	Correct	
Calcium is often used to build and strengthen teeth and bones	42.0	58.0	49.0	51.0	0.32	25.0	7.05	72.0	28.0	<0.0001
Adolescence is the most critical period for calcium absorption	45.0	55. 0	54. 0	46.0	0.20	20. 0	80. 0	67. 0	33. 0	<0.0001
Adolescence is the most crucial phase of bone growth	58. 0	42. 0	59. 0	41. 0	0.88	25. 0	75.0	78. 0	22. 0	<0.0001
The most essential nutrient for maintain healthy bones is calcium and vitamin D	65. 0	35.0	65. 0	35. 0	1.0	13.0	87. 0	68. 0	32. 0	<0.0001
Vitamin D is important in order to absorb calcium from foods properly.	67. 0	33. 0	63. 0	37. 0	0.55	17. 0	83. 0	81. 0	19. 0	<0.0001
Milk products are rich sources of calcium	31. 0	69. 0	35. 0	65. 0	0.53	12. 0	88. 0	30. 0	68. 0	<0.0001

Students' knowledge about Dietary Calcium Intake	Pre intervention				P value	Post intervention				P value
	Study group		Control group			Study group		Control group		
	Wrong	Correct	Wrong	Correct		Wrong	Correct	Wrong	Correct	
Beans are a calcium-rich food.	72.0	28.0	75.0	25.0	0.63	17.0	83.0	79.0	21	<0.0001
Vegetables (cabbage, okra, and spinach) are a calcium-rich food.	58.0	42.0	59.0	41.0	0.88	25.0	75.0	78.0	22.0	<0.0001
Fruits (dates, figs and oranges) are a calcium-rich food.	70.0	30.0	76.0	24.0	0.51	18.0	82.0	69.0	31.0	<0.0001
Vitamin D is abundant in fish oil.	75.0	25.0	81.0	19.0	0.31	17.0	83.0	81.0	19.0	<0.0001
Lack of calcium increases the risk for developing certain diseases.	61.0	39.0	59.0	41.0	0.77	17.0	83.0	63.0	37. 0	<0.0001
Osteoporosis mean	73.0	27.0	77.0	23.0	0.51	20.0	80.0	69.0	31.0	<0.0001
Sufficient intake of calcium during adolescents is essential for osteoporosis prevention.	65.0	35.0	68.0	32.0	0.75	17.0	83.0	63.0	37. 0	<0.0001
Recommended daily requirement of calcium for adolescents boys and girls aged 9 to 18.	86.0	14.0	90.0	10.0	0.38	44.0	56.0	84.0	16.0	<0.0001
Consuming too much cola and coffee can be hazardous to the bones.	62.0	38.0	60.0	40.0	0.79	17.0	83.0	64.0	36. 0	<0.0001
Mean total score	5.4±1.7		5.1 ±1.8		0. 06	11.8±2.6		3.6±1.5		<0.0001

Fig. 1: Knowledge Level of Adolescent Girl Students about Dietary Calcium Intake Pre and Post Intervention among Studied Groups(N=200)

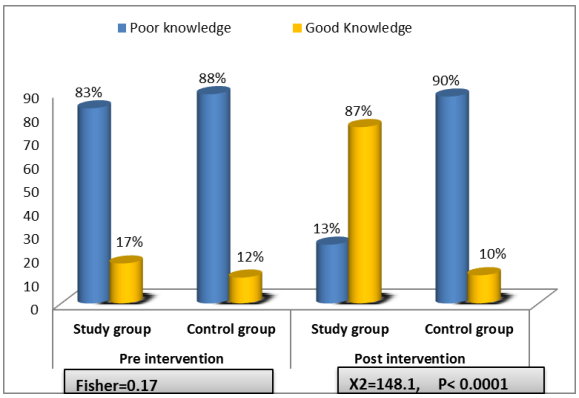

Fig. 2: Practice Level of Adolescent Girl Students about dietary calcium Intake Pre and Post Intervention among Studied Groups (N=200)

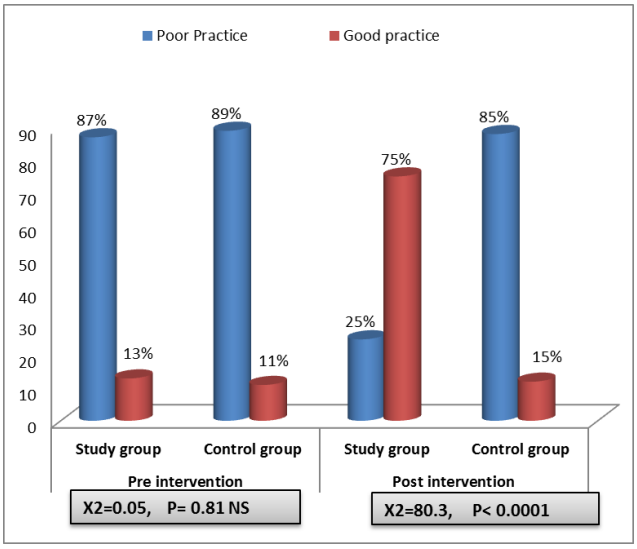

Table 4: Distribution of Mean Total dietary Calcium Intake(mg/daily) Pre and Post Intervention among The Studied Groups (N=200)

Total calcium intake mg/daily	Pre intervention	Post intervention
	Mean ± SD	Mean ± SD
Study group	1036.49±164.47	1231.04±221.01
Control group	901.86±188.35	904.47±183.38
P Value	t=5.3, P<0.0001	t=11.4, P<0.0001

Table 5: Mean score of Health Belief Constructs Subscales Related to Dietary Calcium Intake among Studied Groups Pre and Post Intervention(N = 200)

Health belief construct Subscales related to dietary calcium intake	Pre intervention			Post intervention		
	Study group (100)	Control group (100)	P Value	Study group (100)	Control group (100)	P Value
	Mean ± SD			Mean ± SD		
Perceived susceptibility to the occurrence of diseases resulting from calcium deficiency	11.86±1.26	12.10±0.77	0.25	14.60±1.27	12.35±0.88	<0.0001
Perceived benefits from consumption calcium rich foods	20.84±1.93	20.36±2.07	0.09	26.80±2.03	19.11±2.39	<0.0001
Perceived severity of inadequate intake of dietary calcium as bone fractures, osteoporosis	9.57±1.25	8.97±0.93	0.32	12.74±1.09	8.12±0.94	<0.0001
Perceived barriers to getting enough calcium	15.80±2.34	16.12±1.27	0.54	11.58±1.58	16.53±1.24	<0.0001
Self- efficacy	11.14±1.45	9.95±1.34	0.07	14.21±1.34	9.55±1.18	<0.0001
Grand total score	69.21±3.5	68.9±2.8	0.06	79.93±3.5	65.66±3.2	<0.0001

Discussion

Nutrition is important in the transition from adolescence to adulthood. Malnutrition is linked to stunted growth, decrease cognitive maturation, a lower intellectual quotient, behavioral problems, and an increased risk of getting infectious diseases in children and adolescents. Adequate calcium consumption during childhood and adolescence is consequently critical for osteoporosis prevention, which is why teenagers' calcium intake profiles are being studied (Lappe et al., 2017). Moreover, the nutritional status of adolescent girls, who will later become future mothers, has a significant impact on the community's nutritional conditions (Meenakshi &Hajistha, 2019). According to Ghajari et al., (2016), revealed that intervention strategies should focus on improving female students' awareness and practices concerning calcium-rich foods to enhance their intake. Calcium deficiency has a negative consequence; if it is not prevented in students, it will result in bone loss and fractures in later life (Amini et al., 2014). So, the present study aimed to examine the effectiveness of the nutrition intervention based on HBM for promoting dietary calcium intake among adolescent girl students.

Regarding to socio-demographic characteristics, the current study revealed that the mean age of study group of adolescent girl students' was 13.42± 0.59 compared to 13.35±0.63 among the control group with non-significant statistical differences between study and control groups regarding each item in socio-demographic characters (P>0.05 for each). These results attributed to the researcher was keen to randomly select the study participants in both the study and control groups in order to confirm that any improvement in the level of the study sample would result from the nutritional education intervention and not due to the presence of any individual differences between the two groups. These results supported with the study conducted by Naghashpour et al (2014), to assess the impact of nutrition education to improve dietary calcium intake among Iranian female students with sample size for intervention group was 95 subjects and control group was 93 subjects and there was no substantial difference between the two groups regarding socio-demographic data according to the findings. Additionally, consistent with Mousaviasl et al (2016) who assessed effect of teaching based on the HBM on preventive behaviors of osteoporosis in 172 students female aged 11-14 year and showed that there was no significant difference between characteristics of control and intervention group with p value >0.05.

The current study's first hypothesis stated that the knowledge level and mean total score about dietary calcium intake among the study group will be improved

after the implementation the nutrition intervention based on HBM compared to the control group. Supporting for this hypothesis, the present finding revealed that at post intervention, there was a highly significant improvement in the different items of knowledge and levels concerning dietary calcium intake among the study group compared to the control group ($p<0.0001$). In addition, comparing mean total post intervention knowledge score between study and control groups reveals a higher mean score among study group comparing to control group (11.8 ± 2.6 vr 3.6 ±. 1.5) and the difference was high statistically significant ($P<0.0001$).These findings were attributed to the effectiveness of the HBM -based nutrition education, which included the use of illustrated teaching approaches and the preparation of instructional material depending on adolescents' knowledge levels at pre-intervention. These findings that are in line with the study performed in Egypt by Salem & Said, (2018), to assess the "effect of HBM-based nutrition education on secondary school adolescent girls' food patterns in Sharkia governorate" and demonstrated that there was an improvement in the mean of nutrition knowledge score with highly significant difference at post intervention where($p <0.01$). They concluded that teaching built on HBM improved not just teenage females' nutritional knowledge, but also helped them put part of it into practice. Also, in line with the findings of a study done by Raikar et al (2020), to ascertain the impact of a nutrition teaching session on adolescent girls students aged 13-19 in India. They reported that nutrition knowledge was found poor among school adolescent girls, which significantly improved after the nutrition education session. Moreover, in accordance with a study conducted by Jadgal et al (2020) on female elementary students in Iran, who reported that mean score of knowledge and behavior before and after intervention was not significant in the control group >0.05 but it was significant in the intervention group. In line with Keshani et al., (2019), who examined the effect of HBM on improving diet quality among adolescents, showed that after the intervention, the experimental group's knowledge level had greatly improved, and mean differences were increased. The experimental group's diet quality increased, which was significantly different from the comparison group's.

The present study's second hypothesis reported that the students' practice level related to dietary calcium intake among the study group will be improved after using implementation the nutrition intervention based on HBM compared to the control group. Supporting for this hypothesis, the present result showed that at the pre intervention, most of the study group and control group had poor practice level related to dietary calcium intake with no statistically significant difference compared to post intervention, the good practice level among study group were increased versus control group and the difference was statistically significant ($P<0.0001$).The outcomes were in line with the study achieved via Ghoreishi et al., (2020), on student girls and revealed that among the study group, there was high significant improvement in student girls' practice post intervention ($p <0.01$).Also, consistent with Zarshenas et al., (2017),who revealed intervention program had positive effect on students' health practice related nutrition. In addition, support with research study by Naghashpour et al., (2014), found that nutrition education based on HBM improved nutrition awareness, and behavior in high school girl students who received dietary calcium. Moreover, according to a study accomplished by Charles Shapu et al., (2020), showed that health education intervention among adolescents have significantly improved their nutrition practices. In the same line with Mousaviasl et

al., (2016), who analyzed the impact of the HBM's on osteoporosis prevention among female school students. The study found that following the intervention, there were substantial statistical differences in mean scores of preventative behaviors between the experimental and control group. The HBM-based health education program appeared to be more successful than typical didactic health education in boosting daily calcium intake.

Regarding the mean total of dietary daily calcium intake, the present study's third hypothesis reported that that the mean total of dietary calcium intake (mg/day) among the study group will be higher after the implementation the nutrition intervention based on HBM than the control group. Supporting for this hypothesis, the present result revealed that at the pre intervention, no statistically significant difference in the mean total of dietary calcium intake (mg/day) among study group (1036.49±164.4) and control group (901.86±188.35). This result showed that the average of dietary calcium consumption per day is less than the recommended dietary daily requirement of calcium for adolescent girls among the studied groups. In comparison to post intervention, there was a highly statistically significant improvement in the mean total of dietary calcium intake (mg/day) among study group (1231.04±221.01) compared to 904.47±183.38 among control group (P <0.0001).These findings were supported by a systematic literature study in Canada undertaken by Srbely et al., (2019), to identify the features of successful dairy and/or calcium interventions directed at school children. They reported that five of the fourteen studies involved in the analysis revealed a significant improvements in dairy or calcium consumption of children. Moreover, consistent with a randomized controlled trial by Bourne et al., (2021), who intended at improving dietary calcium consumption among Canadian children and showed that there was a significant increase in overall calcium consumption and calcium from dairy after 8 weeks (P 0001). Also, in the same line with Pandza et al (2016) who estimated adolescent nutrition knowledge as well as calcium intake in Croatia and concluded that the mean calcium consumption of all subjects was 1285.55± 654.77 mg, which is less than the recommended amount. Similarly, Khattar et al., (2020), who evaluated the nutrition education's impact on the nutritional intake of 10-11 year old girls in Mumbai Government schools. They found that post nutrition education; the mean of calcium intake was statistically significant increased from 693±87.74 mg to 81±56.09 mg.

The present study's fourth hypothesis reported that the study group will have higher mean total score of perceived susceptibility to disease, severity from deficiency of dietary calcium intake, benefits of dietary calcium consumption and self-efficacy while will have lower mean total score of perceived barriers after the implementation the nutrition intervention based on HBM than the control group. Supporting for this hypothesis, the present result revealed that at post intervention among the study group, there was a highly significant increase in mean total score of perceived benefits of calcium-rich foods consumption, susceptibility to the occurrence of diseases resulting from calcium deficiency, risk resulting from a deficiency of calcium intake, and self-efficacy while there was significant decrease in barriers to obtaining enough calcium, compared to the control group (P<0.0001 for each). The current study's finding was consistent with Salem and said (2018) who pointed out the Egyptian secondary school adolescent girls' mean scores of HBM constructs were also statistically significantly improved after intervention. In the same

line with Jeihooni et al., (2017), who indicated that in an experimental sample of primary school girls, the mean score of the HBM components was better than the control group. Moreover, supported by Mansour et al., (2017), found that young adult female' average scores of susceptibility to osteoporosis, seriousness, and benefits of calcium consumption were significantly higher post-intervention than before. Also, low level of perceived barriers to calcium intake was improved post-intervention. Also, this result was in line with Zohrehkhoshnood et al., (2015), who conducted a study to assess the influence of education program based on HBM on osteoporosis preventive behaviors among Iranian females and illustrated that the education based on HBM had a positive effect for increasing the average score of the perceived benefits of calcium intake and osteoporosis preventive behaviors. Moreover, a study among female school students completed by Mousaviasl et al (2016), showed substantial statistical differences in mean HBM construct scores between the experimental and control groups post intervention. In line with Keshani et al., (2019), showed that the experimental group of adolescents' HBM constructs and knowledge had greatly improved, and mean differences were increased after the intervention.

Conclusion

The findings of this study revealed that nutrition intervention based on HBM among the study group had a significant positive effect on promoting adolescent girls' awareness, and practice habits related to dietary calcium intake as well as significant increase in the mean total of dietary calcium rich foods consumption (mg/day) compared to the controls group. Moreover, post intervention, there was a statistical significant differences between the study and control groups in mean total score of HBM structures including perceived benefits of calcium-rich foods consumption, susceptibility to the occurrence of diseases, risk resulting from a deficiency of calcium intake, and self-efficacy, while found a significant decrease in barriers to obtaining enough calcium

Recommendations

The need of establishing nutrition interventions based on HBM in schools to promote adolescent girls' calcium intakes, as well as emphasizing on parents and providing recommendations for enhancing calcium-rich food availability at home.

Nutrition interventions based on the HBM should be used in community health promotion in general and adolescent health promotion in particular.

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