

# Knowledge, Beliefs, and Preventive Behaviors Regarding Osteoporosis among University Students: Scoping Review

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## ABSTRACT

**Context:** Osteoporosis is a universally growing health problem. Adequate calcium intake and physical activity, alongside a high level of knowledge and health beliefs, play a crucial role in preventing or delaying diseases.

**Aim:** This scoping review provides an overview of university students' prevailing knowledge, beliefs, and behaviors regarding osteoporosis.

**Methods:** CINAHL, PubMed, and MEDLINE databases were searched to cover the period between 2014 to 2019. Twenty-seven articles were selected out of 4078 were retrieved. The following searching terms were used: (osteoporosis knowledge OR osteoporosis awareness) AND osteoporosis beliefs AND (osteoporosis practices OR osteoporosis behaviors OR calcium intake OR physical activity) AND (osteoporosis OR bone mineral density) AND (nursing students OR university students OR undergraduate students OR college-age students OR young adults). Finally, the level of osteoporosis knowledge, health beliefs, preventive behaviors, the relationship between practices/behaviors and lifestyle with bone health, and the educational intervention's significant/nonsignificant positive effect on the students' osteoporosis knowledge, the prevailed beliefs, and the level of engagement in the osteoporosis preventive behaviors were documented.

**Results:** Most articles demonstrate that the students' osteoporosis knowledge was insufficient and seriously lacking in osteoporosis's perceived susceptibility and severity. This finding clarified that most students were not adequately engaging in the osteoprotective preventive behaviors (Physical activity and Ca intake). Also, the finding indicates that following a healthy lifestyle and engaging in osteoprotective behaviors positively affect BMD and vice versa.

**Conclusion:** The lack of osteoporosis awareness among the university students and the low perception of osteoporosis susceptibility and severity explains why most participants are not engaged in osteoporosis preventive behaviors due to the strong influence of personal beliefs, perceptions, and misconceptions. Therefore, it is important to design educational programs targeting these groups to raise awareness and change their subsequent beliefs.

**Keywords:** Knowledge, beliefs, preventive behaviors, osteoporosis, university students

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## 1. Introduction

Osteoporosis is a systemic skeletal disease characterized by low bone mass or bone mineral density (BMD), microarchitectural deterioration of bone tissue leading to increased fragility of the bone, and increased risk of fracture (*National Institutes of Health [NIH], 2001*). According to the Centers for Disease Control and Prevention, osteoporosis was diagnosed in 4.5 million (10 percent) women aged 50 years (*CDC, 2012*). Worldwide, one in three women and one in five men over 50 are at risk of osteoporotic fracture, causing more than 8.9 million fractures per year, resulting in an osteoporotic fracture every 3 seconds (*International Osteoporosis Foundation [IOF], 2017*).

Both women and men can be affected by osteoporosis with aging. The rate and microstructural deficits are different between the two genders. In women, bone loss is usually accelerated after menopause within the first ten years. While in men, bone loss is not accelerated generally, except for men who suffer from a disease or consequences

of a treatment (e.g., hypogonadism, prostate cancer), but occurs over time. Because of that, the risk of developing the disease is higher in females (*Bilal et al., 2017*).

Throughout childhood, a growth spurt in height and bone mass is gained relatively slowly and suddenly accelerated with the onset of puberty, reaching the peak of bone mass shortly after the height peak is gained. Peak bone mass is the maximum amount of bone accumulated during young adulthood when a stable skeletal state is reached (*Weaver et al., 2016*). A longitudinal study identified that the ages of peak bone mass in women for lumbar spine BMD were between the ages of 33 and 40 years, whereas the totals of hip BMD were between 16 and 19 years. However, the timing of peak bone mass varies according to the skeletal site (*Berger et al., 2010*). 39% of the total body bone mineral is obtained during the four years surrounding the peak of bone accretion, while 95% of the adult bone mass has been reached four years after the peak (*Baxter-Jones et al., 2011*).

Studies showed that the peak of bone mineral density could be increased by young adults, promote long-term bone health, and reduce the risk of disease later in life by maintaining a well-balanced diet, including food rich in

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calcium, physical activity, and healthy lifestyle practices (McLendon & Woodis, 2014). Therefore, young adults are a targeted group for osteoporosis prevention. When young adults optimize their bone density, the progression of osteoporosis and its extent may be stopped or delayed.

The prevention is still considered preferable and cost-effective despite new therapies for osteoporosis treatment (Kamran et al., 2016). The National Institute of Health Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy state that although all populations can be affected by osteoporosis, it can be prevented by achieving maximal BMD through following osteoporosis preventive behaviors of adequate calcium intake and weight-bearing exercise during childhood and adolescence, and up to the third decade of life (up to age 30), then to maintain the peak of BMD and bone health stable afterward (NIH, 2001). National nutrition surveys indicate that many people consume less than half of the recommended calcium to build and maintain healthy bones (NIH, 2018).

Moreover, adult bone health can be improved by following weight-bearing exercises such as hopping and jumping or progressive resistance exercise, alone or in combination (Beck et al., 2017). In order to maintain or increase bone mass density, progressive resistance exercise has been identified as the most promising technique. The reason is that during the progressive resistance exercise, a variety of muscular loads are applied to the bone, which induces stimuli and promotes an osteogenic bone response (Kim et al., 2018).

The influence of osteoporosis knowledge on healthy behavior has not been studied broadly. However, the results in the literature are consistent with the factors that influence osteoporosis knowledge. These factors are sociodemographic characteristics, educational level, gender (women are more knowledgeable), and the presence of relatives with osteoporosis (Werner, 2005). There is an obvious awareness among the general public about osteoporosis. However, a lack of knowledge about its risk factors, treatment, and consequences, along with poor knowledge about preventive behaviors, indicates that the general population is less likely to take action to prevent osteoporosis (Zakai & Zakai, 2015).

Since most primary osteoporosis prevention programs have focused on young adults, a concern is that young adults may not be aware of osteoporosis risk factors and thus not participate in preventative behavior. Young adults will benefit from being informed about how proper nutrition and regular exercise can help them achieve optimal peak bone mass. Therefore, considering the critical long-term effects of this condition on adults, young adults must become better informed about the causes and symptoms of osteoporosis (Endicott, 2013).

Health care professionals and health promotion educators face a great challenge when encouraging young women and men to engage in osteoprotective health practices. Even though these younger adults consider knowledgeable about the osteoporosis, they still do not believe that they are at high risk of developing it later in life; therefore, they do not believe that such preventive

measures should be taken (Clark & Lavielle, 2015; Edmonds, 2009; Evenson & Sanders, 2015).

The Health Beliefs Model suggests that the perception of the individual risk (perceived susceptibility) to develop a disease determines the chances of that person to participate in the detection of the disease, adopting healthy practices, and undertaking preventative measures (Edmonds, 2009; Evenson & Sanders, 2015). The theory indicates that perceived susceptibility is influenced by how likely a person feels they will develop the disease and perceived severity (the seriousness of the disease) (Edmonds, 2009; Gammage et al., 2012). There are similar perceptions among younger men, as they assume that osteoporosis is mostly an illness acquired by older women, not men (Clark & Lavielle, 2015; Edmonds, 2009; Evenson & Sanders, 2015; Khosla et al., 2017). In addition, individuals must believe that the benefits of participating in disease detection, adopting healthy practices, and undertaking preventative measures (perceived benefits) greater than the perceived barriers to such practices (Gammage et al., 2012).

## 2. Significance of the study

An epidemiological study in Saudi Arabia reported that 34% of healthy Saudi women and 30.7% of men between 50 and 79 are osteoporotic (Albogami et al., 2014). However, there is a gap in the literature on changing health behaviors depending on knowledge and beliefs among students, and it has not been extensively studied (Zakai & Zakai, 2015). Therefore, it is important to understand the link between osteoporosis knowledge, osteoporosis-related beliefs, and osteoporosis preventive behaviors among the students, leading to evidence-based interventions to raise awareness about osteoporosis and change subsequent beliefs (Gammage & Klentrou, 2011).

## 3. Aim of the study

Accordingly, this scoping review aimed to provide an overview of university students' prevailing knowledge, beliefs, and behaviors regarding osteoporosis.

## 4. Methodology

### 4.1. Search Strategies

This scoping review methodology was based on five stages methodology outlined by Arksey and O'Malley (2005). First, the PICOT questions were identified to guide this search process in the electronic database. Then, relevant articles were identified by performing an electronic search in the databases between September and October 2019. Recent articles were collected between 2014 and 2019 to select the updated literature based on inclusion and exclusion criteria. Finally, the thematic framework and review matrix was completed to collate, summarize, and report the results.

A combination of the keywords was used, which include: (osteoporosis knowledge OR osteoporosis awareness) AND osteoporosis beliefs AND (osteoporosis practices OR osteoporosis behaviors OR calcium intake OR

physical activity) AND (osteoporosis OR bone mineral density) AND (nursing students OR university students OR undergraduate students OR college-age students OR young adults).

The following electronic databases were searched: Database of Cumulative Index of Nursing and Allied Health Literature "CINAHL," Database of the National Library of Medicine "PubMed" and Database of Medical Literature Analysis and Retrieval System Online "MEDLINE."

#### 4.2. Research question

The research question of this scoping review was defined using the PICOT (Population-Intervention-Comparison-Outcome-Time) format (Melnyk et al., 2011). The PICOT question was, "What are the prevailing knowledge, beliefs, and practices/behaviors regarding osteoporosis in university and college students?"

##### 4.2.1. The population

The population of interest was defined as university and college students (male and female). Any study does not mention that the young adults enrolled in the university were excluded from this review.

##### 4.2.2. The interventions

This review included all studies that evaluated university students' osteoporosis beliefs or/and knowledge or/and behaviors. Also, this review included the studies examining the relationship between university students' behaviors (Ca intake and physical exercise) and lifestyle regarding bone health. In addition, examine the effect of different educational interventions on knowledge, beliefs, and behaviors regarding osteoporosis in the retrieved articles.

##### 4.2.3. The outcome measures

The outcome measures were based on literature to examine the level of osteoporosis knowledge (good, average, or poor). The prevailed beliefs and the level of student's commitment to practice the preventive behaviors are broadly grouped into two categories: Actively engaged in osteoporosis preventive practices (adequate calcium intake and adequate engagement in physical activity) or not actively engaged in osteoporosis preventive practices. Relationships between practices/ behaviors (Ca intake and physical exercise) and lifestyle with bone health among university students, besides the effect of different educational interventions on knowledge, beliefs, and behaviors regarding osteoporosis were also documented.

#### 4.3. Inclusion criteria

The most relevant articles were identified certain inclusion criteria to answer the PICOT question, which included the following:

- Articles examine knowledge, beliefs, or behaviors regarding osteoporosis and focus on universities and college students.

- Articles that are available in the English language.
- Articles published in the last five years between 2014-2019.
- Quantitative and qualitative studies were included.

The retrieved articles were screened using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis), containing a four-phase flow diagram in Figure 1. Initially, 4078 articles were retrieved (1500 from PubMed, 1371 from CINAHL, 1151 from MEDLINE, and 56 added manually), and titles/abstracts were screened. After that, 3982 articles were removed because they were irrelevant, 96 full-text articles were screened, then 18 articles were removed for duplication. After following the inclusion and exclusion criteria, 51 articles were excluded accordingly. Finally, the remaining 27 full-text articles were retrieved to be included in this scoping review.

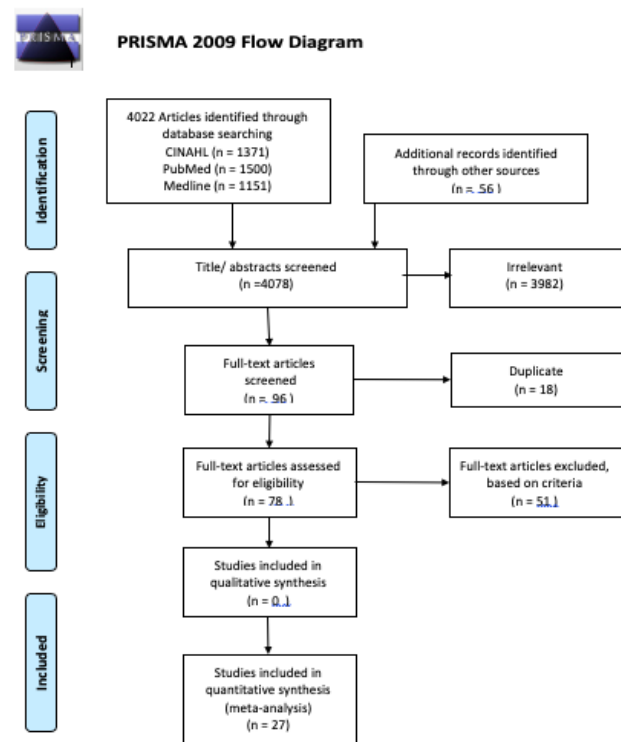


Figure1: PRISMA Flow Diagram Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement guidelines (Moher et al., 2009).

## 5. Results

The retrieved articles were categorized into six themes using thematic analysis. First is the level of osteoporosis knowledge, including three levels (good, average, or poor). The second theme is beliefs, which includes four sub-themes regarding the psychological dimensions of the health beliefs model (perceived severity and susceptibility to get osteoporosis and perceived benefits and barriers of increased Ca intake and increased physical exercise). The third theme is preventive behaviors, including the level of Ca intake and whether physical activity if they are actively engaged or not.

**Table (1): Themes and subthemes of the reviewed studies.**

Themes	Subthemes	Studies	
<b>Level of osteoporosis knowledge</b>			
	Good	<i>Khan et al. (2019); (Elnaem et al., 2017).</i>	
	Average	<i>De Silva et al. (2014); Enteshari et al. (2019); Khan et al. (2014); Ramli et al. (2018); Bilal et al. (2017); Ghaffari et al. (2015).</i>	
	Poor	<i>Elnaem et al. (2017); DeRuiter-Willems (2018); Evenson and Sanders (2015); Shahbo et al. (2016); Almalki et al. (2016); Kim and Kim (2015).</i>	
<b>Osteoporosis health Beliefs</b>			
	Perceived susceptibility,	<i>De Silva et al. (2014); Bilal et al. (2017); DeRuiter-Willems (2018); Lein et al. (2014); Lein et al. (2016); Nguyen (2015); Evenson and Sanders (2015).</i>	
	Perceived severity,		
	the Perceived benefit of increased exercise and increased Ca intake, the Perceived barrier of increasing exercise and increasing Ca intake		
<b>Osteoporosis preventive behaviors: Physical activity and Ca intake.</b>			
	Actively engaged in preventive behaviors.		<i>Khan et al. (2014); Nguyen (2015);</i>
	Not actively engaged in preventive behaviors	<i>De Silva et al. (2014); DeRuiter-Willems (2018); Park et al. (2015); Ramli et al. (2018); Bilal et al. (2017); Hammad and Benajiba, (2017); Johnson et al. (2015); Nakazono, (2014); Kaveh et al. (2014); Zeidan et al. (2016); Rose et al. (2018); Lein et al. (2014); Lein et al. (2016); Kim and Kim (2015); Lim et al. (2018); Kim et al. (2016); Evenson and Sanders (2015); Hervás et al. (2018).</i>	
<b>Relationship between practices/ behaviors (Ca Intake and Physical exercise) and lifestyle with Bone Health among university students</b>			
		<i>Lim et al. (2018); Kim et al. (2016); Johnson et al. (2015); Hervás et al. (2018); Hammad and Benajiba (2017); Nakazono (2014).</i>	
<b>The effect of different educational interventions on knowledge, beliefs, and behaviors regarding osteoporosis.</b>			
		<i>Way (2016); Nguyen (2015); Lein et al. (2014); Lein et al. (2016); Kaveh et al. (2014); Shahbo et al. (2016); Evenson and Sanders, (2016).</i>	

The fourth theme outlines the relation between practices/behaviors (Ca Intake and physical exercise) and lifestyle with bone health among university students. Moreover, the fifth theme is to assess the impact of the educational intervention on the level of each variable (knowledge, beliefs, and behaviors).

Twenty-seven articles were retrieved in this scoping review examining and evaluating knowledge, beliefs, and behaviors/practices regarding osteoporosis among university/college students. These articles were performed in various geographical locations. The majority of articles were performed in the US (*DeRuiter-Willems, 2018; Evenson & Sanders, 2015; Rose et al., 2018; Lein et al., 2014; Lein et al., 2016; Nguyen, 2015; Johnson et al., 2015; Way, 2016*), KSA (*Almalki et al., 2016; Hammad & Benajiba, 2017; Zeidan et al., 2016; Khan et al., 2019*), Korea (*Park et al., 2015; Kim & Kim, 2015; Lim et al., 2018; Kim et al., 2016*), Malaysia (*Khan et al., 2014, Ramli et al., 2018; Elnaem et al., 2017*), Iran (*Kaveh et al., 2014; Enteshari et al., 2019; Ghaffari et al., 2015*), Spain (*Hervás et al., 2018*), Egypt (*Shahbo et al., 2016*), Japan (*Nakazono, 2014*), Pakistan (*Bilal et al., 2017*) and Sri Lanka (*De Silva et al., 2014*) respectively. On the other hand, 14 articles were carried out on the medical and health science students, and five examined the medical and non-medical science students. In contrast, eight articles recruited students from other non-medical/health science fields.

**Theme 1: Level of osteoporosis knowledge**

Thirteen out of twenty-seven articles assessed osteoporosis knowledge levels among university students. According to most of the retrieved articles, the level of knowledge was divided into good, average, and poor. In addition, most of these articles (n= 9) recruited the students from medical and health science fields; two articles involved the students from medical and non-medical science fields, and only two studies were carried out in other non-medical/health science fields.

**1.1. Sub-theme: Good level of knowledge**

Only two studies reported a good level of knowledge among the university's students. The first study was a cross-sectional study performed by *Khan et al. (2019)* at four different cities in KSA, with 337 students (176 females; 161 males) recruited from King Abdelaziz University, Jeddah; Umm Al-Qura University, Makkah; Tabuk University, Tabuk and Taibah University, Medina. The students were from different faculties, including medical/health fields and other non-medical/health fields. The authors developed a self-reported questionnaire to assess awareness and knowledge of osteoporosis.

The result showed that 12.2% of the students had osteoporosis. Also, 86.3 % of overall students had average 139 (41.2%) or good 152 (45.1%) knowledge level score and was correlated with education (r2=0.28) and gender (r2=0.27); p<0.0001. Knowledge increased positively with increasing the education level (preparatory year (47.8±15.3), undergraduate (53.5±16.5), and postgraduate

(61.8±15.8); (all  $p < 0.0001$ ). Moreover, females have better knowledge scores than males (57.7±15.4 vs. 48.8±16.8;  $p < 0.0001$ ).

The second study was another cross-sectional study with three hundred forty-eight students retrieved from medicine, pharmacy, and allied health sciences in a Malaysian University who evaluated the knowledge level about osteoporosis (Elnaem *et al.*, 2017). A revised Osteoporosis Knowledge Test questionnaire was used to evaluate the participants' level of knowledge. The results showed variation in knowledge scores between different study programs students. The allied health sciences program students have the highest scores in the overall total knowledge (median=20) and nutrition subscale (median=16). However, for the exercise subscale, a similar median score was shared by both the students in allied health science and medicine (median=11.5). Also, 69.91% of the pharmacy respondents scored below than median score. In addition, more than half of the respondents showed adequate knowledge of osteoporosis (50.6%) is almost the same as those who have inadequate knowledge (49.4%).

### 1.2. Sub-theme: Average level of knowledge

In addition, six articles reported that the students had an average level of knowledge about osteoporosis. One of these articles was a descriptive cross-sectional study done by De Silva *et al.* (2014) with 186 female medical school entrants (mean age=20.7±2.1 years) of the faculties of medicine in Colombo and Kelaniya Universities in Sri Lanka involved to determine the knowledge, beliefs, and practices regarding osteoporosis among young females entering medical schools in Sri Lanka. Osteoporosis Knowledge Assessment Tool (OKAT), Osteoporosis Health Belief Scale (OHBS), Questionnaire to assess positive and negative practices, and Food Frequency Questionnaire were used to measure osteoporosis's knowledge, beliefs, and practice. The results indicated that the highest percentage of the participants (51.6%,  $n=96$ ) had an average score (40-60) on the knowledge test, while 40.8% ( $n=76$ ) had a poor score (<40). However, in-depth knowledge of risk factors and protective factors was lacking.

Enteshari *et al.* (2019) assess the knowledge of Ardabil Medical University students toward osteoporosis by using a descriptive cross-sectional study among 258 students from the medical field (dental, medicine, pharmacy, anesthetics, radiology, laboratory sciences, health information, nursing, midwifery, health, and operating rooms). The authors developed the knowledge score determined by a research-based knowledge questionnaire. The researchers found that 61.3 percent of the students had average knowledge, 31.2 percent had good knowledge, and 7.5 percent had poor knowledge about osteoporosis. Also, they found that health students had the highest average knowledge with 72.3% and dental students had the lowest knowledge level with 16.7%.

Another exploratory cross-sectional study evaluated osteoporosis knowledge and perceptions among university students in Malaysia (Khan *et al.*, 2014). Pre-validated self-administered questionnaire to assess knowledge, attitude,

and practices (KAP) of 461 students at University Sains Malaysia (USM), Pulau Penang. The study reported that the participants had a moderate/fair level of knowledge ( $n=298$ ) (64.6%) and practice ( $n=264$ ) (57.2%) but a poor attitude ( $n=268$ ) (58.1%) regarding osteoporosis. Moreover, females showed higher knowledge scores than males (243.89 vs. 216.12,  $p=0.02$ ). However, still, there was no statistically significant difference between attitudes and practices of males and females, with the only exception of personal susceptibility to suffering from osteoporosis.

Another cross-sectional study to investigate the knowledge, attitude, and practice (KAP) regarding osteoporosis among allied health sciences students in a public university in Malaysia (Ramli *et al.*, 2018). Osteoporosis Knowledge Assessment Tool (OKAT) was used to measure knowledge and self-constructed questionnaire based on literature to assess the attitude and practices of 106 allied health sciences students. The result indicated that the participants had a moderate/fair level of knowledge (male mean: 39.09, female mean 40.13) and attitude (male mean: 35.65, female mean: 35.98).

In 2017 Bilal *et al.* assessed knowledge, attitudes, and practices about osteoporosis among female medical school entrants in Karachi, Pakistan using a descriptive cross-sectional study. Four hundred female medical school entrants (mean age 19.4±1.2 years) of DOW University of Health Sciences (DUHS) and Jinnah Sindh Medical University (JSMU) were involved in this study. Osteoporosis Knowledge Assessment Tool (OKAT), Osteoporosis Health Belief Scale (OHBS), a Food Frequency Questionnaire, and a questionnaire to assess favorable and unfavorable behaviors were used to achieve the aim of the study. The result revealed that participants with insufficient knowledge of the disease were not adequately applied preventative practices. There is a serious lack of adoption of preventative practices for osteoporosis. This finding was primarily due to little appreciation of the seriousness of osteoporosis. The results revealed that 196 (49.0%) students had an average knowledge score relating to osteoporosis, while only 8.0% of the total students had a good score, 164 (41.0%) had a poor score, and 6 (1.5%) had a very poor score.

Moreover, in a descriptive-analytical study conducted by Ghaffari *et al.* (2015), 239 students in the health faculty of Shahid Beheshti University of Medical Sciences in Iran were investigated for their awareness of osteoporosis (calcium intake and physical activity). A valid and reliable questionnaire measured the students' awareness of osteoporosis, including nine items to assess calcium intake and 15 items to assess physical activity. The result indicates that only 19.2% of students had a good level of knowledge about osteoporosis, and 64% had an average level of knowledge.

### 1.3. Subtheme: Poor level of knowledge

A poor level of knowledge was reported in six articles. One of these articles was included in the poor and average level of knowledge theme. This article reported that poor

and average knowledge levels had almost the same percentage (Elnaem et al., 2017).

DeRuiter-Willems (2018) conducted a quantitative, inferential study to differentiate between knowledge, health beliefs, self-efficacy regarding osteoporosis, and the actual performance of osteoporosis-preventing activities among college students of various racial/ethnic groups. Five hundred eleven online survey responses were collected from students in Eastern Illinois University with an age range between 18 to 24 years. Osteoporosis Health Belief Scale (OHBS) was used to measure knowledge level. The Revised Osteoporosis Knowledge Test (rOKT), Osteoporosis Preventing Behaviors Survey (OPBS), and Osteoporosis Self-Efficacy Scale (OSSES) were used. The highest possible score was 32, and the range of correct scores was 4-29, with an average score of 16.38, which is equal to 51% of the total scores considered failing (poor knowledge).

In 2016, Evenson & Sanders examined osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and vitamin D intakes as measures of preventive behaviors in young adults by using a pre and post-test design. One hundred fifty-three students enrolled in an introductory nutrition course in Midwestern college were recruited and divided into control group, treatment group 1 (lecture), and treatment group 2 (hands-on activities). Osteoporosis Knowledge Test (OKT\_D), Health Belief Scale (OHBS-D), Osteoporosis Self-Efficacy Scale (OSSES-D), and 3-day food records were used to answer the research question. The result revealed that total knowledge scores at baseline OKT-D were considered low. They were analyzed as a total group (n=153) to assess the validity of the osteoporosis scales. Only data from the control group (n=51) was used to determine the scales' internal consistency and test-retest reliability to avoid the impact of the educational intervention.

Another one-group quasi-experimental study in Egypt was conducted by Shahbo et al. (2016) to assess osteoporosis knowledge and self-efficacy perceptions among 133 female students who work and study at the Port-Said Faculty of Nursing. Knowledge and self-efficacy scores were measured by using Osteoporosis Knowledge Test (OKT) and Osteoporosis Self-Efficacy Scale (OSSES). The mean scores of osteoporosis knowledge and osteoporosis self-efficacy perception were low at baseline before the intervention.

In KSA, a cross-sectional study was done by Almalki et al. (2016) to evaluate osteoporosis among 140 medical interns using Osteoporosis Knowledge Assessment Tool (OKAT). The result showed that osteoporosis knowledge among interns was poor, with the correctly answered questions mean 10.62/20 (53%). Moreover, a significant relationship was found between the higher OKAT scores and high students' GPA scores ( $p=0.002$ ) and those interested in health education ( $p<0.001$ ), significantly high in female interns. However, there was no significant difference between awareness and gender.

Furthermore, Kim & Kim (2015) conducted a cross-sectional survey to examine if cognitive factors, including nutrition knowledge, outcome expectations, self-efficacy,

and eating behaviors differ according to calcium intake based on the social cognitive theory. Two hundred forty female college students attending university in Seoul, Korea, were involved in the study and divided after analysis of the result into two groups (high calcium intake and low calcium intake groups): 22.1% of students were in the high calcium intake group ( $HC \geq 650$  mg/day) and 77.9% of students were in low calcium intake group ( $LC < 650$  mg/day). The authors developed a questionnaire regarding calcium intake, nutrition knowledge, outcome expectations, self-efficacy, and eating behaviors based on literature reviews to answer the research question. The result revealed inadequate nutrition knowledge, and they scored 67.5 out of 100.

Most of the articles included in this scoping review revealed that the participants had an average to low knowledge about osteoporosis.

## Theme 2: Osteoporosis health beliefs

The number of articles that examines osteoporosis beliefs among universities students was only seven articles (De Silva et al., 2014; DeRuiter-Willems, 2018; Lein et al., 2014; Lein et al., 2016, Evenson & Sanders, 2015; Nguyen, 2015; Bilal et al., 2017). The osteoporosis health beliefs were divided in a current study into five subscales addressing the Health Beliefs Model (Perceived susceptibility, perceived severity, perceived benefit of increased exercise and increased Ca intake, the perceived barrier of increased exercise and increased Ca intake, and health motivation). Each subscale was divided into high and low.

Most studies reported low scores in perceived susceptibility to getting osteoporosis and perceived osteoporosis severity. A descriptive cross-sectional study by De Silva et al. (2014) reported that perceived susceptibility to osteoporosis was low, with only 13.9% (n=26) of women agreeing that their chances of getting osteoporosis are high. Bilal et al. (2017) revealed that perceived susceptibility was low as only 14.0% of the participants believed they were at high risk for osteoporosis. In addition, a study by DeRuiter-Willems (2018) suggested that college students somewhat disagreed with their susceptibility and seriousness of developing osteoporosis. However, they somewhat agreed with the benefits and the barriers of exercise and calcium intake.

Moreover, a pilot study was conducted by Lein et al. (2014) to evaluate the effectiveness of a theory-based computer-tailored osteoporosis prevention program on calcium and vitamin D intake and osteoporosis health beliefs in young women. The study tested whether adding bone density testing to the intervention improved the outcomes. Health Belief Scales (OHBS) and Calcium/Vitamin D Screener questionnaire were used to measure health beliefs scores and calcium and vitamin D intake levels in 100 staff and students at the University of Alabama at Birmingham.

The participants were divided into two groups: 50 received the computer-tailored program with brief



counseling, and 50 received the same intervention plus the heel bone density testing. The overall mean for perceived osteoporosis susceptibility and severity scale was low at baseline in both groups. Only the perceived susceptibility increased in both groups immediately and one month after assigned interventions. Additionally, both groups experienced statistically significant decreases in perceived barriers to obtaining adequate vitamin D intake. On the other hand, both groups perceived few barriers to calcium intake at baseline with no change after the assigned interventions.

Also, another three-group randomized trial study was conducted by *Lein et al. (2016)* to evaluate the effectiveness of theory-based osteoporosis prevention programs on calcium and vitamin D intakes and osteoporosis health beliefs in young women. One hundred fifty-two students who attended a large southeastern university were divided into three groups: the Brochure group (n=51), the computer-tailored program group (n=51), and the same computer-tailored program with brief verbal feedback (n=50). Health Belief Scales and the Block Calcium/Vitamin D Screener were used to collect the data. At baseline, the perceived osteoporosis susceptibility and severity scale was low in all groups. After the designed intervention, they experienced significant decreases in perceived barriers to adequate vitamin D intake and significant increases in perceived osteoporosis susceptibility and severity.

Thirty-seven young men undergraduate college students enrolled in health education classes were recruited for the experimental study and allocated into two groups: The treatment group (n=17) and the control group (n=20) to test the effectiveness of the osteoporosis prevention education intervention in altering osteoporosis health beliefs and increasing the osteoporosis-preventive behaviors (*Nguyen, 2015*). Osteoporosis Health Belief Scale (OHBS), Osteoporosis Self-Efficacy Scale (OSES), and Exercise and Calcium Behaviors Scale (ECBS) was used to collect the data. Both groups had low perceived susceptibility to osteoporosis and low to moderate perceived severity of osteoporosis.

In 2016, *Evenson & Sanders* carried out a pre/post-test study to examine osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and vitamin D intakes as preventive behaviors in young adults. Barriers to exercise, barriers to calcium intake or barriers to vitamin D intake scores were generally very low before intervention and significantly increased regardless of the osteoporosis educational intervention. Besides, health beliefs were a significant predictor of dietary calcium and vitamin D intake.

All the articles included in this scoping review indicate that most of the participants had low perceived osteoporosis severity and perceived osteoporosis susceptibility.

### **Theme 3: Osteoporosis preventive behaviors: Physical activity and Ca intake.**

Twenty articles evaluated osteoporosis preventive behaviors through the scoping review, including physical

activity and Ca intake. Some articles examine physical activities and Ca intake, and some examine only one of these two behaviors.

#### **3.1.1. Actively engaged in preventive behaviors**

Only two articles found that the student actively engaged in osteoprotective physical activity and had an adequate level of Ca consumption. This study was done by *Khan et al. (2014)*, and the result revealed that the participants had a moderate/fair level of practice (n=264) (57.2%) but a poor attitude (n=268) (58.1%) regarding osteoporosis. Besides that, the Chinese scored maximum in both the knowledge and practice section, followed by Malays and then Indians. (Chinese: 264.46, Malay: 228.32, Indian: 194.04, others: 236.94, p = 0.00). Another study by *Nguyen (2015)* found that the participants had adequate exercise per week but inadequate calcium consumption per day.

#### **3.1.2. Not actively engaged in preventive behaviors**

Eleven articles examine the engagement level of the students in preventive physical activity. On the other hand, eighteen articles examine the level of calcium consumption. Most of these articles report that the students did not have an adequate level of osteoporosis-preventive behaviors (physical activity and Ca intake). Nine of these articles examine both physical activities and Ca intake.

*De Silva et al. (2014)* found that practices for preventing osteoporosis were inadequate. The mean calcium intake was 528 mg/day, and only 18.8% (n=35) of the participants achieved the Recommended Daily Allowances (RDA) for Calcium. The exercise was grossly inadequate in most participants, and only 13.6% (n=23) engaged in the recommended exercises. In addition, only 3.8% (n=7) of the participants currently engaged in specific behaviors to improve bone health, while 10.8% (n=20) had thought of routinely engaging in such behaviors.

Furthermore, *DeRuiter-Willems (2018)* found that most women, 76.7%, and men, 53.7%, do not take adequate calcium. Also, found that the participants did not meet the recommended levels from weight-bearing exercise to achieve benefits, and only 21.2% of all women and 32.9% of all men reported 20–30 minutes of weight-bearing physical activity 5–7 times per week (110–150 minutes to 140–210 minutes per week).

*Park et al. (2015)* performed a cross-sectional study based on Nola J. Pender's Health Promotion Model to identify the dietary habits and health behaviors of 160 female Korean nursing students and analyze their relationship to obesity and BMD. Also, it aimed to investigate some of the modifying factors related to obesity and osteoporosis, including demographical, biological, and behavioral characteristics. Health behaviors survey, three-day dietary records, a 24-hour recall method, Body Mass Index and BMD using Achilles Express ultra-sonometer were used.

The result demonstrated that a relatively large number

of students had vitamin D (n=104, 65%) and calcium (n=84, 52.5%) deficiencies but displayed excessive cholesterol (n=86, 53.8%) and sodium (n=137, 85.6%) intakes. Additionally, one hundred one (63.1%) students denied regular exercise participation. Additionally, *Ramli et al. (2018)* found that the participants had poor practice (male mean: 19.94, female mean: 20.72) regarding osteoporosis.

*Bilal et al. (2017)* performed a descriptive cross-sectional study, and the result revealed that only 29.0% of the participants met the RDA for calcium ( $\geq 700$  mg/day) despite the high motivation toward consuming a calcium-rich diet. Also, exercise levels were insufficient in terms of duration and the recommended type of exercise, and only 12.0% of the participants engaged in exercises according to the recommended guidelines. Moreover, only 5.5% of the students were involved in definitive behaviors to improve bone health.

One hundred and one young female students aged 20–24.9 years at King Saud University campus in Riyadh, KSA, were enrolled in a cross-sectional study to analyze risk factors leading to osteopenia and osteoporosis among young female students (*Hammad & Benajiba, 2017*). Anthropometric measurements, Quantitative Ultrasonography (QUS) measurements, Lifestyle Factors Questionnaires, and the Simple Food-Frequency Questionnaire were used to collect the data. The result showed a significant increase in soft drinks consumption (75%), a high prevalence of physical inactivity (61%) and remarkable low consumption of milk and dairy products (less than two times per week by 91%), and calcium and vitamin D supplement (86.8%). Furthermore, more than 33% of the participants were diagnosed with osteopenia (n=32) and osteoporosis (n=3) compared to the healthy group (n=66).

*Johnson et al. (2015)* carried out a prospective cohort study to determine if selected predictors of BMD in African American and Caucasian college-aged women differ by race. 101 local African American (n=50) and Caucasian (n=51) females at a Mississippi University were recruited for the study. Anthropometric assessment and dual-energy x-ray absorptiometry (DXA) were measured, Osteoporosis Knowledge Test (OKT), a 7-day Physical Activity Recall Questionnaire, and their food intake over the next four days were filled to answer the research questions. The finding reported that participants had a higher prevalence of low spinal BMD (38.6%) than low femoral BMD (7.9%). Besides, only 26.7% of participants met the Recommended Dietary Allowance (RDA) for calcium, and less than one-quarter of 21.8% met physical activity requirements. Furthermore, one-third (33.7%) of this sample reported no physical activity.

Moreover, eleven articles examine either physical activity or Ca intake alone, and most of these articles report inadequate engaging levels in osteoprotective behavior. Only two studies stated an adequate level of recommended Calcium intake. *Evenson & Sanders (2015)* examine the dietary calcium and vitamin D intakes as measures of preventive behaviors in young adults. The results showed that the average dietary calcium intake was approximately

1078 mg daily, which met the recommended level. The average dietary vitamin D intakes were approximately 224 IU per day, which is below the recommendation of 600 IU.

In 2018, a study carried out by *Hervás et al.* to analyze the relationship between physical activity (PA), physical fitness, body composition, and dietary intake with bone Stiffness Index (SI), measured by Quantitative Ultrasonometry (QUS) in 156 young university students (61 men and 95 women). Beside QUS to measure bone status, anthropometrics, food records for five days, muscles and knee strength measured by an isokinetic dynamometer, and physical activity measured by wearing an accelerometer used to collect the data. The result showed that males' calcium intake ( $1018 \pm 348$  mg/day) reached the recommended value while the females' average ( $814 \pm 206$  mg/day) was less than that recommended by the WHO (1000 mg/day) ( $p < 0.001$ ).

However, the remaining nine articles stated that the level of osteoprotective practice, either physical exercise or Ca intake was insufficient. In 2014, three years followed up study for 334 Japanese females enrolled in a university at the age of 18 years to determine the lifestyle factors that influence the maintenance of calcaneus Osteo-sono assessment index (OSI) in young adult females around the time when peak bone mass is attained (*Nakazono, 2014*). The students were divided into the OSI loss group (n= 112) and the OSI gain/stable group (n= 222). Quantitative ultrasound (QUS) measurements, Self-Administered Questionnaires (Physical activities, milk, and dairy products), and a Semiquantitative Food Frequency Questionnaire were used to collect the data. The finding demonstrated that the mean intensity levels of physical activity were about 1.6 METs in both groups, suggesting that most subjects were sedentary in their daily lifestyle. Therefore, discontinuing leisure time impact-loading exercises at university was associated with an increased risk of OSI loss compared with those performing impact-loading exercises at university.

*Kaveh et al. (2014)* did a randomized controlled trial to investigate the effect of an empowerment program on physical activity-related stages of change and self-efficacy in preventing osteoporosis among university students. One hundred fifty-two female students of Shiraz University of Medical Sciences were registered in the experimental group (n=76) and control group (n=76). The data were collected by the Stages of Exercise Change Questionnaire (SECQ). The results indicated that participants had behavioral constructs below the expected levels in pre-intervention. Only 8.6% of the participants started to exercise at a standard level (Action group) in the past six months, and 1.3% exercised for more than six months at the standard level (Maintenance group).

In KSA, *Al Madinah Al Munawara, Zeidan et al. (2016)* performed a cross-sectional study to screen for low bone mineral density among 279 female students and employees of Taibah University using Quantitative Ultrasound (QUS), Structured Self-Reported Questionnaire including lifestyle habits, Anthropometric Measurements, and Biochemistry Blood samples of serum calcium, serum



phosphorus, vitamin D. The overall prevalence of low BMD was 9% (25/279), with 6% for osteopenia and 3% for osteoporosis. Also, 87% (243) of the participants had less than 1000 mg/day of calcium intake, not meeting the recommended daily intake. However, calcium levels and other blood biochemistry measures were within normal standards, except vitamin D and plasma OC levels were consistently lower in the study group.

Another study was carried out by *Rose et al. (2018)* to evaluate 1,730 undergraduate college students' attitudes and behaviors concerning milk and dairy consumption and their association with calcium intake at a large, public Midwestern University. The online survey was used to measure the attitudes and behaviors regarding calcium consumption. Median calcium intake across all participants was 928.6 mg/day, with males consuming higher calcium intakes than females ( $p < 0.001$ ). Also, 78.7% of females and 62.1% of males aged 18 years old and 60.0% of females and 45.4% of males aged 19 years and older failed to meet the recommendation [18 years (1,300 mg/day calcium) and 19 years and older (1,000 mg/day calcium)].

*Lein et al. (2014)* conducted a study using a Calcium/Vitamin D Screener questionnaire at the University of Alabama at Birmingham. They found that the two studied groups of young women at the baseline consumed well below the Recommended Daily Allowance with a mean daily intake of calcium 569.27 mg and vitamin D 229.12 IU and statistically significantly increased calcium and vitamin D intake from baseline to 1 month after the interventions. Another study by *Lein et al. (2016)* used the same questionnaire in a large southeastern university. The results showed that all groups significantly improved calcium intakes from an average of 650 mg/day at baseline to above 820 mg/day one month after interventions but did not reach the required 1000 mg/day. However, there was no significant difference between the three groups.

In addition, *Kim and Kim (2015)* found that the majority of the participant placed in the low calcium intake group (LC, <650 mg/day) (LC,  $n=187$ , 77.9%) while the high calcium intake group (HC,  $\geq 650$  mg/day) was only 22.1% of the participants ( $n=53$ ). Those with high calcium intake (HC) had more favorable outcome expectations, higher self-efficacy in consuming calcium-rich foods, and more desirable eating behaviors than those in the LC group.

In Korea, *Lim et al. (2018)* carried out a study to measure bone mineral density (BMD) among 161 (68 male and 93 female) college students from Soonchunhyang University to analyze the differences in BMD according to lifestyle. A survey for the general information, lifestyle, regular exercise, and eating habits and the 24-hr recall method for three days were used to collect data. The result showed that 8.8% of males and 10.8% of females were classified as osteopenia, and male college students who smoke and all college students who frequently eat fast food had significantly lower BMD. Also, calcium intake was higher in male college students ( $575.2 \pm 282.2$ ) than in females ( $428.1 \pm 5,308.7$ ), but there was no significant difference in calcium intake between the groups. However, still, both groups were below the RDA. Moreover, 77.9%

from male students ( $n=53$ ) and 88.2% from the female student ( $n=82$ ) not engaging in regular exercise.

Another cross-sectional study in Korea investigated the relationship between bone-specific physical activity (BPAQ) scores, body composition, and bone mineral density (BMD) in 73 college students from the universities in Seoul and Gyeonggi province, South Korea (*Kim et al., 2016*). 24-hour food intake recall and a Bone-specific Physical Activity Questionnaire (BPAQ) were used to collect the data. BPAQ scores were positively related to total hip and Femoral Neck (FN) BMD and no correlations were detected in L2-L4. 24.7% and 27.4% of the participants were classified as osteopenia FN and L2-L4, respectively. Also, the participants showed lower calcium ( $432.3 \pm 236.7$  mcg) and vitamin D intake ( $3.7 \pm 3.9$  mcg), which did not meet the RDA for calcium (1000 mg/day) and Vitamin D intake (15 mcg/day).

Most of the articles recruited in this scoping review indicate that most participants were not actively engaged in osteoporosis protective behaviors.

#### **Theme 4: Relationship between practices/ behaviors**

Six articles evaluate the relationship between lifestyle, physical activity or Ca intake, and BMD. *Lim et al. (2018)* analyzed BMD differences according to lifestyle. The result shows that male college students who are smoking ( $p=0.003$ ) and all college students who frequently eat fast food had significantly lower BMD (male= $p < 0.001$ , female= $p < 0.015$ ).

*Kim et al. (2016)* examined the relationship between bone-specific physical activity questionnaire (BPAQ) scores, body composition, and bone mineral density (BMD). The BPAQ scores (past, pBPAQ; current, cBPAQ; total, tBPAQ) were used to comprehensively account for lifetime physical activity related to bone health. The result indicates that the bone-specific physical activity (BPAQ) scores were positively related to total hip (past BPAQ  $r=0.308$ ,  $p=0.008$ ; total BPAQ,  $r=0.286$ ,  $p=0.014$ ) and Femoral Neck (FN) BMD (pBPAQ  $r=0.309$ ,  $p=0.008$ ; tBPAQ,  $r=0.311$ ,  $p=0.007$ ) and no correlations were detected in lumbar spine (L2-L4). While no significant relationships were found in the current BPAQ ( $p > 0.05$ ). Besides, there was a positive correlation between vitamin D intake and L2-L4 ( $p=0.025$ ), but other dietary intake variables were not significant ( $p > 0.05$ ).

In another study, a selected predictor (Family history of osteoporosis, osteoporosis knowledge, current physical activity, age at menarche, calcium, and oral contraceptives) of BMD differ by race (*Johnson et al., 2015*). They found that BMI ( $p=0.001$ ,  $p=0.010$ ) and current physical activity ( $p=0.017$ ,  $p=0.007$ ) were the only statistically significant variables in predicting spinal and femoral BMD, respectively. Race was not a significant predictor of spinal or femoral BMD. 43.6% of individuals classified as low weight also had low spinal BMD, and 75% of those with low weight had low femoral BMD.

In 2018, *Hervás et al.* analyzed the relationship between physical activity (PA), physical fitness, body composition, and dietary intake with bone Stiffness Index (SI), measured by quantitative ultrasonometry in young university students. Moderate-to-vigorous PA (MVPA) was the strongest predictor of SI ( $\beta=0.184$ ;  $p=0.035$ ). SI was most closely related to very vigorous PA in males ( $\beta=0.288$ ;  $p=0.040$ ) and the number of steps/day in females ( $\beta=0.319$ ;  $p=0.002$ ). Additionally, calcium intake was the only nutrition parameter with a positive relationship with SI ( $r=0.217$ ;  $p=0.022$ ). Also, the authors found that very vigorous PA ( $p=0.096$ ) was more strongly associated with a higher bone Stiffness Index (SI) than activities of lower intensity.

*Hammad & Benajiba (2017)* analyze risk factors leading to osteopenia and osteoporosis among young female students. Multiple regression analysis showed that Quantitative Ultrasonography measurements (T-score and Z-score) were negatively associated with soft drink intake and positively associated with exercising, milk and dairy products consumption, and calcium and vitamin D supplementation use ( $p<0.05$ ). In addition, *Nakazono (2014)* determines the lifestyle factors that influence the maintenance of calcaneus Osteo-sono assessment index (OSI) in young adult females around the time when peak bone mass is attained. The result revealed that performing leisure time impact-loading exercise in junior high or high school but discontinuing leisure time impact-loading exercise at university was associated with an increased risk of OSI loss compared with those performing impact-loading exercise at university.

All the articles in this scoping review revealed that engaging in physical exercise, especially weight-bearing (moderate to vigorous) exercise, Ca intake, Vit. D intake, milk and dairy products consumption, and Ca & Vit D supplement intake are positively associated with BMD. While soft drinks, smoking and eating fast food are negatively associated with BMD, low weight is associated with low BMD.

### **Theme 5: The effect of different educational interventions on knowledge, beliefs, and behaviors regarding osteoporosis.**

Seven articles were recruited to examine the effectiveness of different types of educational intervention (lectures, PPT presentations, brochures, computer-tailored presentations, and hands-on activities) and empowerment programs on osteoporosis knowledge level, health beliefs, and adopting the preventive behavior.

*Way (2016)* performed a quantitative non-experimental descriptive pretest/post-test design using a voice/non-voice-enhanced online PowerPoint (PPT) presentation to determine the impact of a teaching module about osteoporosis prevention and treatment on nurse practitioner students' awareness and knowledge. The study included eighteen nursing students from the Wilmington University nurse practitioner program. Osteoporosis Knowledge Test (OKT) was used to measure knowledge level. The voice-

enhanced PPT presentation significantly improved the total knowledge scores ( $p=0.002$ ). The exercise and nutrition subscales significantly improved ( $p=0.01$ ,  $p=0.002$ , respectively). For the non-voice presentation group, the participants demonstrated a nonsignificant improvement (although nearly significant) in total assessment scores.

( $p>0.054$ ). The improvement was statistically nonsignificant ( $p=0.093$ ) for the exercise subscale but significant for the nutrition subscale scores ( $p=0.023$ ).

An experimental study tested an osteoporosis prevention education intervention to alter osteoporosis health beliefs and increase osteoporosis-preventive behaviors to determine the effectiveness and make public health recommendations (*Nguyen, 2015*). The study showed that the osteoporosis prevention education intervention was ineffective in altering osteoporosis health beliefs to increase preventive behaviors. It did not increase the actual osteoporosis-preventive behaviors of self-reported weight-bearing physical activity and calcium consumption ( $p>0.05$ ).

*Lein et al. (2014)* tested whether adding bone density testing to the intervention (theory-based computer-tailored osteoporosis prevention program) improved the outcomes. The result showed that the theory-based computer-tailored osteoporosis prevention program significantly improved osteoporosis beliefs and calcium and vitamin D intakes ( $p<0.001$ ). Otherwise, the bone density test did not improve the outcomes.

*Lein et al. (2016)* conducted a three-group randomized trial study: A brochure group ( $n=51$ ), a computer-tailored program group ( $n=51$ ), and the same computer-tailored program with brief verbal feedback ( $n=50$ ) to evaluate the effectiveness of the theory-based osteoporosis prevention programs on calcium and vitamin D intakes and osteoporosis health beliefs in young women. The finding suggests that all groups experienced significant decreases in perceived barriers to obtaining adequate vitamin D and significant increases in perceived osteoporosis susceptibility and severity. In addition, all groups significantly improved calcium intakes from an average of 650 mg/day at baseline to above 820 mg/day one month after interventions but still did not reach the required 1000 mg/day. However, there was no significant difference between the three groups.

Furthermore, *Kaveh et al. (2014)* carried out a randomized controlled trial to investigate the effect of an empowerment program on physical activity-related stages of change and self-efficacy in preventing osteoporosis among university students. The results showed that the experimental group and the control group exhibited significant statistical increase after the intervention in the stage of change from ( $2.28\pm0.86$ ,  $2.04\pm0.82$ ) to ( $3\pm0.84$ ,  $2.18\pm0.87$ ) in the first post-test to ( $3.22\pm0.84$ ,  $2.3\pm0.89$ ) in the second post-test respectively. However, this increase was more significant in the experimental group.

*Shahbo et al. (2016)* conducted a one-group quasi-experimental study to assess osteoporosis knowledge and self-efficacy perceptions of female students in the Port-Said Faculty of Nursing, Egypt. The result indicated that OKT mean scores in pre-intervention ( $16.32\pm3.15$ ,  $16.32\pm3.15$ )

increased to (20.62±2.05, 18.18±2.99) post-intervention among student participants and employee participants ( $p<0.05$ ). Besides a significant increase in influence on college-age women to adopt lifestyle behavioral changes to exercise ( $p<0.05$ ) and calcium intake with  $p<0.05$  as osteoporosis knowledge increases after the educational program.

Moreover, a pre-/posttest design to examine osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and vitamin D intake measures preventive behaviors in young adults after a nutrition course in Midwestern college (Evenson & Sanders, 2016). The participants were divided into three groups: the control group, the treatment (1) group (lecture), and the treatment (2) group (hands-on activities). Both interventions increased osteoporosis knowledge and health beliefs but not self-efficacy. OKT-D total scores increased significantly over time for all three groups (57% to 72%). Also, there were significant differences in OKT-D total scores between the control group and treatment one group ( $p<0.02$ ). Osteoporosis health beliefs significantly differed over time within groups ( $p<0.002$ ) but not between groups. On the other hand, no significant differences over time or between groups were found for OSES-D total or subscales of the OSES-D, including calcium, exercise, or vitamin D. However, after the intervention, both treatment groups showed an increase in dietary vitamin D intake, while the control group decreased.

Most articles indicate that the educational intervention significantly improved osteoporosis knowledge level, health beliefs, and adoption of preventive behavior.

## 6. Discussion

Health care professionals, especially nurses, are at the frontline in diagnosing and treating osteoporosis for the general population. Moreover, many studies recommended that health care professionals provide individually tailored educational interventions to patients (Schapira et al., 2017; Giuse et al., 2012).

Twenty-seven articles in this scoping review provide an overview of the prevailing knowledge, beliefs, and behaviors regarding osteoporosis among university students. Out of these twenty-seven articles, thirteen articles assessed the level of osteoporosis knowledge among the different university students (De Silva et al., 2014; Enteshari et al., 2019; Khan et al., 2014; Ramli et al., 2018; Bilal et al., 2017; Elnaem et al., 2017; Khan et al., 2019; Ghaffari et al., 2015; DeRuiter-Willems, 2018; Evenson & Sanders, 2015; Shahbo et al., 2016; Almalki et al., 2016; Kim & Kim, 2015). Only two studies done by Khan et al. in 2019 and Elnaem et al. in 2017 reported that the level of knowledge was good and adequate among the students.

In addition, there were six articles reported that the students had an average level of knowledge about osteoporosis (De Silva et al., 2014; Enteshari et al., 2019; Khan et al., 2014, Ramli et al., 2018, Bilal et al., 2017 Ghaffari et al., 2015). On the other hand, six articles reported a poor level of the osteoporosis knowledge among

the students, even though the majority of the students enrolled in the medical and health science fields (DeRuiter, 2018; Evenson & Sanders, 2015; Shahbo et al., 2016; Kim & Kim, 2015; Almalki et al., 2016; Elnaem et al., 2017). Even though most of these articles recruited participants from medical and health science fields, the level of knowledge remains insufficient. This lack of knowledge considers a serious issue facing healthcare professionals because they may not feel confident enough to discuss with their patients about osteoporosis. The patient should feel confident in the primary health care providers when seeking sound advice (Albergaria et al., 2018).

Many studies reported that osteoporosis knowledge among health care professionals is not as adequate and sufficient as it should be (Thakur et al., 2019; Peng, 2019; Dwidmuthe, 2017; Park et al., 2017; Riaz, 2017; Fourie et al., 2015). This finding suggests that university students are less likely to take action in adapting osteoprotective behaviors, which highlights the importance of increasing osteoporosis knowledge by providing designed theory-based educational interventions about osteoporosis and the preventive behaviors targeting peak bone mass and adding focused learning to their curriculum.

Seven articles in this scoping review study the health beliefs regarding osteoporosis (perceived susceptibility, perceived severity, perceived benefit of increased exercise and increased Ca intake, the perceived barrier of increased exercise, and increased Ca intake). All of them indicated that the majority of the participants had low perceived osteoporosis severity and perceived osteoporosis susceptibility (De Silva et al., 2014; Bilal et al., 2017; DeRuiter-Willems, 2018; Lein et al., 2014; Lein et al., 2016; Nguyen, 2015; Evenson & Sanders, 2015), which explained why the majority of the participants not engaging in the preventive behaviors, because they do not have the sense that they are at risk of getting osteoporosis, also, they do not realize the severity of this disease.

Lems & Raterman (2017) reported that osteoporosis is not a common topic to be discussed between health care professionals and patients, and many are not followed up for bone scans or treatment. Nguyen & Okamura's (2014) results showed that studied women had low to moderate perceived susceptibility to osteoporosis and moderate perceived severity of osteoporosis.

However, Aramwiroj et al. (2014) reported that the participants in their study had a low level of perceived susceptibility but a high level in perceived severity and intermediate level in preventive behavior to osteoporosis. Income, received information, perceived susceptibility, and perceived severity factors were significantly related to preventive behavior concerning osteoporosis ( $p=0.001$ ). Al-Muraikhi et al. (2017) reported that the majority of the participating women showed lower perceived susceptibility to osteoporosis (71.7%) but higher perceived benefits of preventive practices (91.7%).

Additionally, twenty articles examine the level of engagement in osteoprotective practices/behaviors (physical exercise and Ca intakes). These articles used many different tools and questionnaires to assess the level of Ca intake and

the level of physical activity. Also, the recommended calcium intake and the adequate level of physical exercise varied extensively between the studies. Therefore, the interpretation of the results needs more caution. However, the findings indicate that most participants were not actively engaged in osteoporosis protective behaviors, which draw attention to the importance of designing compulsory physical exercise programs in their college program. Also, to increase the awareness about the importance of adherence to osteoporosis protective behaviors.

A similar finding was revealed by *Chan et al. (2018)* in their review to summarize the contemporary evidence on bone health knowledge, beliefs, and practice of adolescents and young adults. The reviewed studies showed that most adolescents and young adults had poor knowledge and expressed disinterest in osteoporosis. They believed that other diseases were more serious than osteoporosis, contributing to low perceived susceptibility and seriousness towards this disease.

Also, *Khazaeian et al. (2021)*, in a quasi-experimental study performed on 240 high school female students to investigate the effects of protection motivation theory (PMT)-based training on osteoporosis-preventive behaviors in female high school students in Zahedan, Iran reported that the intervention and control groups showed no significant difference in terms of the mean score of knowledge, theoretical constructs, and preventive behaviors at the baseline ( $p>0.05$ ).

Also, six articles evaluated the relationship between practices/ behaviors (Ca Intake and Physical exercise) and lifestyle with bone health (*Lim et al., 2018; Kim et al., 2016; Johnson et al., 2015; Hammad & Benajiba, 2017; Hervás et al., 2018; Nakazono, 2014*). These articles indicated that engaging in physical exercise, especially weight-bearing (moderate to vigorous), Ca intake, Vit. D intake, milk, dairy products consumption, and Ca & Vit. D supplement intake is positively associated with BMD. While soft drinks, smoking, and fast food are negatively associated with BMD. Furthermore, low weight is associated with low BMD.

Similar findings were reported by *Al-Ayyadhi et al. (2020)* in a study aimed to screen healthy young Kuwaiti future mothers for low bone mineral density (BMD) and to assess their knowledge level about determinants of peak bone mass (PBM) and preventive practices. By logistic regression, less carbonated beverages and coffee consumption positively affect BMD, while inadequate exercises level, indoor exposure to sunlight, and less frequency of brisk walking negatively affect BMD.

In a study, *Han et al. (2021)* investigated the factors influencing adolescents' bone mineral density (BMD). Age, carbonated beverages, snacks, and calcium supplements were variables that showed significant differences in adolescents' BMD. Additionally, correlation analysis found that height, weight, body mass index (BMI), body water, protein, minerals, body fat mass, and skeletal muscle mass were correlated with BMD. Multiple regression analysis identified BMD-associated factors as age, calcium supplements, BMI, body fat mass, and skeletal muscle

mass.

Most reviewed studies indicate that the educational intervention significantly improved osteoporosis knowledge level, health beliefs, and adoption of preventive behavior. However, *Nguyen (2015)* reported that education intervention was ineffective in altering osteoporosis health beliefs to increase osteoporosis preventive behaviors, and it did not increase the actual osteoporosis-preventive behaviors of self-reported weight-bearing physical activity and calcium consumption ( $p<0.05$ ). The ineffective alteration in the osteoporosis health beliefs or increased osteoporosis-preventive behaviors may be that the participants in this study were males, which may feel that this disease affected only or mainly women and because of the late-onset time in males to develop osteoporosis.

*Khazaeian et al. (2021)*, In their study of the effect of protection motivation theory-based training on osteoporosis preventive behaviors, reported a significant difference between the study and control groups in their preventive behaviors (i.e., calcium intake, physical activity, and sunlight exposure) immediately after and two months after the intervention.

Results of *Rastgoo et al. (2019)* in a study aimed to assess the short-term effect of the educational program based on the Beliefs, Attitude, Subjective Norms, Enabling Factors (BASNEF) model on the osteoporosis preventive behaviors in adolescent girls revealed non-statistically significant differences were reported between the groups in terms of knowledge ( $p=0.48$ ), attitude ( $p=0.94$ ), subjective norms ( $p=0.17$ ), behavioral intention ( $p=0.82$ ), enabling factors ( $p=0.62$ ), and osteoporosis preventive behaviors ( $p=0.32$ ). Meanwhile, immediately and one month after the educational program, differences were reported between the two groups in knowledge ( $p<0.001$ ), attitude ( $p=0.002$ ,  $p<0.001$ ), subjective norms ( $p=0.024$ ,  $p=0.001$ ), behavioral intention ( $p<0.001$ ,  $p=0.001$ ), enabling factors ( $p<0.001$ ), and osteoporosis preventive behaviors ( $p<0.001$ ).

However, interpreting these findings requires caution since there was a high risk of heterogeneity in educational intervention's content, depth, and duration. All of the studies do not mention the actual education curriculum besides the wide variations of the used studies' instruments. Moreover, no explicit definition or explanation of the traditional education in the control group. Even though the presence of heterogeneity, results indicated in the majority of the articles that the different educational interventional had a significant/nonsignificant improvement in osteoporosis knowledge level, correcting health beliefs, and adopting a preventive behavior, which emphasizes the importance of providing focused theory-based osteoprotective educational intervention to the students to improve their osteoporosis knowledge, health beliefs, and practice.

The variability of the scores was noticed among the articles, especially the articles that evaluate the level of osteoporosis knowledge and level of the engagement in osteoprotective practices/behaviors (physical exercise and Ca intakes) because the interpretation of the tools' outcomes differed between the articles in the different settings and countries. Therefore, the results of the articles were

inconsistent, which is considered insufficient evidence to generalize the result. In contrast, the Osteoporosis Health Belief Scale (OHBS) results in all articles were good evidence to evaluate the prevailing health beliefs about osteoporosis among university students.

## 7. Conclusion

In conclusion, the findings demonstrate that the students' osteoporosis knowledge was insufficient and seriously lacking in perceived susceptibility and severity. This finding may explain that most students are not adequately engaging in the osteoprotective behaviors (physical activity and Ca intake). Also, the finding suggests that following a healthy lifestyle and engaging in osteoprotective behaviors positively affect BMD and vice versa. Finally, the educational intervention varies in its significant/nonsignificant positive effect on the students' osteoporosis knowledge; the prevailed beliefs and the level of engagement in the osteoporosis preventive behaviors.

## 8. Limitation and implication

The limitations of this scoping review were that most studies, especially which assess the level of osteoporosis knowledge and engagement in the osteoporosis preventive behaviors, used a self-designed questionnaire. It is unclear if such questionnaires were valid and reliable, which raised potential issues concerning the accuracy of the data collected. Besides, the article's quality assessment in this review was not conducted.

## 9. Recommendations

The level of osteoporosis awareness among the universities' students was insufficient, especially since most of the students were enrolled in health sciences programs. Besides, the perceived low level of osteoporosis susceptibility and not engaging in osteoporosis preventive behaviors are due to the strong influence of personal beliefs and perceptions. Because of that, it is important to design educational programs targeting these groups to raise their awareness and change their subsequent beliefs. In addition, health professionals may have an important role in planning prevention education to raise the awareness of osteoporosis among the young adult groups.

Therefore, future studies need to consider the quality of the standard questionnaires to evaluate knowledge, beliefs, and behaviors regarding osteoporosis. In addition, it is necessary to examine the relationships between the osteoporosis knowledge and health beliefs with the level of students' participation in the osteoprotective behaviors to evaluate the effect of the knowledge and beliefs on the level of the students' engagement in the osteoporosis preventive behaviors. Therefore, further research requires more attention to implementing effective strategies to enhance osteoporosis knowledge among health professionals.

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Appendix 1: Data Extraction Table/Review Matrix

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
1	De Silva et al. (2014)  Sri Lanka	To determine the knowledge, beliefs, and practices regarding osteoporosis among young females entering medical schools in Sri Lanka.	Descriptive cross-sectional study	186 female medical school entrants of the Faculties of Medicine in Colombo and Kelaniya Universities.	The mean age was 20.7 ± 2.1 years.	<ul style="list-style-type: none"> <li>- Osteoporosis Knowledge Assessment Tool (OKAT)</li> <li>- Osteoporosis Health Belief Scale (OHBS)</li> <li>- Questionnaire to assess positive and negative practices</li> <li>- Food frequency questionnaire</li> </ul>	<ul style="list-style-type: none"> <li>- Majority of the participants (51.6%, n=96) had an average score (40-60) on the knowledge test, while 40.8% (n=76) had a poor score (&lt;40). However, in-depth knowledge of risk factors and protective factors was lacking.</li> <li>- Perceived susceptibility for osteoporosis was low, with only 13.9% (n=26) of women agreeing that their chances of getting osteoporosis are high.</li> <li>- Practices toward preventing osteoporosis were inadequate.</li> <li>- The mean calcium intake was 528 mg/day, and only 18.8% (n=35) of the participants achieved the Recommended Daily Allowances (RDA) for calcium.</li> <li>- The exercise was grossly inadequate in the majority, and only 13.6% (n=23) engaged in the recommended exercises.</li> <li>- Only 3.8% (n=7) of the participants currently engaged in specific behaviours to improve bone health, while 10.8% (n=20) had thought of routinely engaging in such behaviours.</li> </ul>
2	DeRuiter-Willems. (2018)  Illinois US	To differentiate between knowledge, health beliefs, self-efficacy regarding osteoporosis, and the actual performance of osteoporosis preventing activities among college students of various racial/ethnic groups.	Quantitative, inferential study	511 online survey responses were collected from students in Eastern Illinois University with various racial/ethnic groups.	18- 24 years	<ul style="list-style-type: none"> <li>- Osteoporosis Health Belief Scale (OHBS)</li> <li>- The Revised Osteoporosis Knowledge Test (OKT)</li> <li>- Osteoporosis Preventing Behaviours Survey (OPBS)</li> <li>- Osteoporosis Self-Efficacy Scale (OSES).</li> </ul>	<ul style="list-style-type: none"> <li>- The range of correct OKT answers was 4–29, with the average being 16.38. This finding indicated that the average score was only about 51% correct, which considered falling</li> <li>- The findings suggest that college students somewhat disagreed with their susceptibility and seriousness of developing osteoporosis. However, they somewhat agreed with the benefits and barriers of exercise and calcium intake.</li> <li>- The results of this survey indicate that most women (76.7%) and men 53.7% do not take an adequate calcium level.</li> <li>- The details suggested that they did not meet the recommended levels from weight-bearing exercise to achieve benefits,</li> <li>- Only 21.2% of all women and 32.9% of all men reported 20–30 minutes of weight-bearing physical activity 5–7 times per week (110–150 minutes to 140–210 minutes per week)</li> </ul>
3	Rose et al. (2018)  Columbus US	To evaluate college students' attitudes and behaviours concerning milk and dairy consumption and their association with calcium intake.	Descriptive cross-sectional study	Participants were 1,730 undergraduate students at a large, public, Midwestern University.	18 to >25 years	Online survey to measure the attitudes and behaviours regarding calcium consumption	<ul style="list-style-type: none"> <li>- Median calcium intake across all participants was 928.6 mg/day, with males consuming higher calcium intakes than females (<math>p&lt;0.001</math>).</li> <li>- 78.7% of females and 62.1% of males aged 18 years old and 60.0% of females and 45.4% of males aged 19 years. Older failed to meet the recommendation [18 years (1,300 mg/day calcium) and 19 years and older (1,000 mg/day calcium)].</li> </ul>

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
4	Nakazono (2014) Japan	To determine the lifestyle factors that influence the maintenance of calcaneus Osteo-sono assessment index (OSI) in young adult females when peak bone mass is attained.	Three years follow up study	334 Japanese females enrolled in a university at the age of 18 years. Two categories: - OSI loss group (n=112). - OSI gain/stable group (n= 222).	18 -21 years	- Quantitative ultrasound QUS measurements. - Self-administered questionnaires (Physical activities and milk and dairy products). - A semiquantitative food frequency questionnaire	- The mean intensity levels of physical activity were about 1.6 METs in both groups, suggesting that most subjects were sedentary in terms of their daily lifestyle. - Discontinuing leisure time impact-loading exercises at university was associated with an increased risk of OSI loss compared with those performing impact-loading exercises at university.
5	Evenson and Sanders (2016) US	To examine osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and vitamin D intakes as measures of preventive behaviours in young adults.	A pre-/post-test design	153 students enrolled in an introductory nutrition course in Midwestern college. Three groups: - Control group - treatment 1 (lecture) - treatment 2 (hands-on activities).	18-23 years	- Osteoporosis Knowledge Test (OKT) modified to OKT_D - Health Belief Scale (OHBS) modified to (OHBS-D) - Osteoporosis Self-Efficacy Scale (OSES) modified to (OSES-D). - Three-day food records	- OKT-D total scores were considered low at baseline and increased significantly over time for all three groups (57% to 72%). - Barriers to exercise, barriers to calcium, or barriers to vitamin D scores were generally very low before intervention and significantly increased regardless of the osteoporosis educational intervention. - Average dietary calcium intake was approximately 1078 mg per day which met the recommendations level. Average dietary vitamin D intakes were approximately 224 IU per day, well below the recommendation of 600 IU. Both treatment groups showed an increase in dietary vitamin D intake, whereas the control group decreased. - Health beliefs were a significant predictor of dietary calcium intake $p<0.021$ and vitamin D intake $p<0.047$ . - Both interventions increased osteoporosis knowledge and health beliefs but not self-efficacy.
6	Kaveh et al. (2014) Iran	To investigate the effect of an empowerment program on physical activity-related stages of change and self-efficacy in preventing osteoporosis among university students.	Randomized controlled trial	152 female students at Shiraz University of Medical Sciences Two groups: -The experimental group (n=76) -The control group (n=76)	The students' mean age - The experimental group: 20.20±1.395 -The control group: 20.08±0.813	- The Stages of Exercise Change Questionnaire (SECQ)	- Pre-intervention findings showed that participants had behavioral constructs below the expected levels. Only 8.6% of the participants started to exercise at a standard level (Action group) in the past six months, and 1.3% exercised for more than six months at the standard level (Maintenance group). - The results showed that the experimental group and the control group received a significant statistical increase after the intervention in the stage of change from (2.28±0.86, 2.04±0.82) to (3±0.84, 2.18±0.87) in the first post-test to (3.22±0.84 2.3±0.89) in the second post-test respectively. However, this increase was more significant in the experimental group.

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
7	Shahbo et al. (2016) Egypt	To assess the levels of osteoporosis knowledge and self-efficacy perceptions of female students in Port-Said Faculty of Nursing.	A one-group quasi-experimental design	The sample consisted of 133 females working and studying in the nursing faculty in port-Said, Egypt.	18 to 46 years.	- Osteoporosis Knowledge Test (OKT). - Osteoporosis Self-Efficacy Scale (OSES).	- The mean scores of osteoporosis knowledge and osteoporosis self-efficacy perception were low at baseline and increased post-intervention. - OKT mean scores in the pre-intervention (16.32±3.15, 16.32±3.15) and increased to (20.62±2.05, 18.18±2.99) post-intervention among student participants and employee participants, respectively ( $p<0.05$ ). - Significant increase in influence on college-age women to adopt lifestyle behavioural changes to both exercise $p<0.05$ and calcium intake with $p<0.05$ as osteoporosis knowledge increases after the educational program.
8	Lein et al. (2014) Alabama, US	To evaluate the effectiveness of a theory-based computer-tailored osteoporosis prevention program on calcium and vitamin D intake and osteoporosis health beliefs in young women. Additionally, this study tested whether adding bone density testing to the intervention improved the outcomes.	A pilot study (A repeated-measures, 2-group randomized trial design)	100 staff and students at the University of Alabama at Birmingham. They were either studying or practicing in a health-related profession. Two groups: -Received the computer-tailored program with brief counselling (n=50). -Received the same intervention plus bone density testing of the heel (n=50).	19 to 25 years	- Health belief scales (OHBS) - Calcium/Vitamin D Screener questionnaire	- The overall mean for perceived osteoporosis susceptibility and severity scale was low at baseline in both groups. Only the perceived susceptibility increased in both groups immediately and one month after assigned interventions. - Both groups also experienced statistically significant decreases in perceived barriers to obtaining adequate vitamin D intake. - Both groups perceived few barriers to calcium intake at baseline with no change after the assigned interventions. - At baseline, the two groups of young women consumed well below the recommended daily allowance with a mean daily intake of calcium 569.27 mg and vitamin D 229.12 IU. They showed statistically significantly increase in calcium and vitamin D intake from baseline to one month after the interventions. - The theory-based computer-tailored osteoporosis prevention program resulted in significant improvements in osteoporosis beliefs and calcium and vitamin D intakes. The bone density test did not improve the results.
9	Lein et al. (2016) Florida US	To evaluate the effectiveness of theory-based osteoporosis prevention programs on calcium and vitamin D intakes and osteoporosis health beliefs in young women.	Three group randomized trial design	152 students who attended a large Southeastern university. Three groups: - Brochure group (n=51). - Computer-tailored program group (n=51). - The same computer-tailored program with brief verbal feedback (n=50).	19 to 25 years	- Health Belief Scales - The Block Calcium/Vitamin D Screener	- The perceived osteoporosis susceptibility and severity scale was low in all groups at baseline. - All groups experienced significant decreases in perceived barriers to obtaining adequate vitamin D and significant increases in perceived osteoporosis susceptibility and severity. - All groups significantly improved calcium intakes from an average of 650 mg/day at baseline to above 820 mg/day one month after interventions but still did not reach the required 1000 mg/day. However, there was no significant difference between the three groups.

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
10	Park et al. (2015) Korea	To identify Korean females and young adults' dietary habits and health behaviours and analyse their relations to obesity and BMD. This study also aimed to investigate some of the modifying factors related to obesity and osteoporosis, including demographical, biological, and behavioural characteristics.	Cross-sectional study that was designed based on Nola J. Pender's Health Promotion Model	160 female nursing students.	The average age of the subjects was 20.6	- Three-day dietary records. - A 24-hour recall method. - Health behaviours survey. - Body Mass Index. - BMD using Achilles Express ultrasonometer.	- One hundred one (63.1%) students denied participating in regular exercise. - A relatively large number of students had vitamin D (n=104, 65%) and calcium (n=84, 52.5%) deficiencies but displayed excessive cholesterol (n=86, 53.8%) and sodium (n=137, 85.6%) intakes.
11	Enteshari et al. (2019) Iran	To assess the knowledge of Ardabil Medical University students toward osteoporosis.	A descriptive cross-sectional study	258 students of dentistry, medicine, pharmacy, anaesthetics, radiology, laboratory sciences, health information, nursing, midwifery, health, and operating rooms of Ardabil Medical University.	- The age range was 18-39 - The age group of 18-23 had the majority, 93.4%.	A research-based questionnaire about knowledge	- 31.2 percent had good knowledge, 61.3 percent had average knowledge, and 7.5 percent had poor knowledge about osteoporosis. - The highest level of knowledge was achieved for MD students with 49% and the highest average knowledge related to health students with 72.3%, and the lowest knowledge level was for dental students with 16.7%. - 59.7 % of students had low dairy consumption - The participants had moderate/fair level of knowledge (n=298, 64.6%) and practice (n=264, 57.2%) but poor attitude (n=268, 58.1% regarding osteoporosis. - Chinese scored maximum in both knowledge and practice sections, followed by Malays and Indians. (Chinese: 264.46, Malay: 228.32, Indian: 194.04, Others: 236.94, $p=0.00$ ). - Females showed statistically higher knowledge scores than males (243.89 vs. 216.12, $p=0.02$ ). However, still, there was no statistically significant difference between attitudes and practices of males and females, with the only exception of personal susceptibility to suffering from osteoporosis.
12	Khan et al. (2014) Malaysia	To evaluate knowledge and perceptions of osteoporosis among university students in Malaysia belongs to different age groups, gender, and ethnicity.	An exploratory cross-sectional study	461 students at University Sains Malaysia (USM), Pulau Penang, Malaysia. - Undergraduate 294 - Postgraduate 167 Schools of Pure Arts 155, Applied Arts 155, and Sciences 151.	Mean age 24.61±5.51 years.	Pre-validated self-administered questionnaire to assess knowledge, attitude, and practices (KAP)	- The participants had moderate/fair level of knowledge (n=298, 64.6%) and practice (n=264, 57.2%) but poor attitude (n=268, 58.1% regarding osteoporosis. - Chinese scored maximum in both knowledge and practice sections, followed by Malays and Indians. (Chinese: 264.46, Malay: 228.32, Indian: 194.04, Others: 236.94, $p=0.00$ ). - Females showed statistically higher knowledge scores than males (243.89 vs. 216.12, $p=0.02$ ). However, still, there was no statistically significant difference between attitudes and practices of males and females, with the only exception of personal susceptibility to suffering from osteoporosis.
13	Ramli et al. (2018) Malaysia	To analyse the knowledge, attitude, and practice (KAP) regarding osteoporosis among allied health sciences students in a public university in Malaysia, its associated socio-demographic factors, and the association between the KAP.	A cross-sectional study	106 allied health sciences students in a public university in Malaysia.	The mean age of the participants was 22.39 years	- Osteoporosis Knowledge Assessment Tool (OKAT). - Self-constructed questionnaire based on literature to assess attitude and practices questionnaire	- The participants in the present study had a moderate/fair level of knowledge (male mean: 39.09, female mean 40.13) and attitude (male mean: 35.65, female mean: 35.98) but poor practice (male mean: 19.94, female mean: 20.72) regarding osteoporosis.



No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
14	Bilal et al (2017) Pakistan	To assess knowledge, attitudes, and practices about osteoporosis among female medical school entrants in Karachi.	A descriptive cross-sectional study	400 female medical school entrants of DOW University of Health Sciences (DUHS) and Jinnah Sindh Medical University (JSMU).	Mean age 19.4±1.2 years	- Osteoporosis Knowledge Assessment Tool (OKAT) - Osteoporosis Health Belief Scale (OHBS) - A food frequency Questionnaire - Questionnaire to assess favourable and unfavourable behaviours	- Participants possessed an insufficient knowledge of the disease, which was not adequately applied in preventative practices. There is a serious lack of adoption of preventative practices for osteoporosis. This finding was primarily due to little appreciation of the seriousness of osteoporosis. - Only 8.0% of the participants had a good score of knowledge about osteoporosis, 196 (49.0%) subjects had an average score, 164 (41.0%) had a poor score, and 6 (1.5%) had a very poor score. - Perceived susceptibility was low as only 14.0% of the participants believed they were high risk for osteoporosis. - Despite the high motivation toward consuming a calcium-rich diet, only 29.0% of the participants met the RDA for calcium ( $\geq 700$ mg/day). - Exercise levels were insufficient in terms of duration and the recommended type of exercise. - According to the recommended guidelines, only 12.0% of the participants engaged in exercises. - Moreover, only 5.5% of subjects were involved in definitive behaviours to improve bone health.
15	Almalki et al. (2016) Taif, Saudi Arabia	To assess the osteoporosis knowledge among medical interns.	A cross-sectional study	140 interns, 27% were interested in internal medicine, 24% in general surgery, and 3.6% in orthopaedics	Age is not identified in the study.	Osteoporosis Knowledge Assessment Tool (OKAT)	- Osteoporosis knowledge among interns was poor, with the mean of the correctly answered questions being 10.62/20 (53%). - A significant relationship was found between the higher OKAT scores and a high student GPA score ( $p=0.002$ ) and those interested in health education ( $p=0.001$ ), significantly high in female interns. However, there was no significant difference between awareness and gender. - Questions related to diet and exercise were among the least frequently correctly answered questions.
16	Hammad and Benajiba (2017) KSA Riyadh	To analyse risk factors leading to osteopenia and osteoporosis among young female students.	A cross-sectional study	101 young female students at King Saud University campus.	Age range 20–24.9 years	- Anthropometric measurements - Quantitative Ultrasonography (QUS) measurements - Lifestyle factors questionnaires. - Simple food-frequency questionnaire	- More than 33% of the participants were diagnosed with osteopenia ( $n= 32$ ), osteoporosis ( $n=3$ ) compared to the healthy group ( $n= 66$ ). - The result showed a significant increase in the soft drinks consumption (75%), a high prevalence of physical inactivity (61%) and remarkable low consumption of milk and dairy products (less than two times per week by 91%), and calcium and vitamin D supplement (86.8%). - Multiple regression analysis showed that T-score and Z-score were negatively associated with soft drink intake and positively associated with exercising, milk and dairy products consumption, and calcium and vitamin D supplementation use ( $p<0.05$ )

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
17	Zeidan et al. (2016) Al Madinah Al Munawara KSA	To screen for low bone mineral density among young adult Saudi women using quantitative ultrasound (QUS) and exploring the high-risk groups.	A cross-sectional study	279, female students and employees of Taibah University, includes 15 colleges in three clusters, main campus, medical campus, and Alssalam campus	20-36 years old	- BMD assessed using QUS - A structured self-reported questionnaire including lifestyle habits included smoking, physical activity, sun exposure, and calcium intake. - Anthropometric measurements - Biochemistry blood samples of serum calcium, serum phosphorus, and vitamin D.	- The overall prevalence of low BMD was 9% (25/279), with 6% for osteopenia and 3% for osteoporosis. - Vitamin D and plasma OC levels were consistently lower in the study group, but all other blood biochemistry measures were within a normal standard range, including calcium levels. - 87% (243) of the participants had less than 1000 mg/day of calcium intake.
18	Kim and Kim (2015) Korea	To examine if cognitive factors, including nutrition knowledge, outcome expectations, self-efficacy, and eating behaviours, differ according to calcium intake based on the Social Cognitive Theory.	A cross-sectional survey design	240 female college students attending university in Seoul, Korea. Two groups: - High calcium intake (HC, $\geq 650$ mg/day) (HC, n=53, 22.1%). - Low calcium intake (LC, $< 650$ mg/day) (LC, n=187, 77.9%),	Mean age of subjects was 20.4 years	- Questionnaire regarding calcium intake, nutrition knowledge, outcome expectations, self-efficacy, and eating behaviours. - Food frequency questionnaire.	- Nutrition knowledge was inadequate and had a score of 67.5 out of 100. Also, no difference was founded according to calcium intake groups. - Most of the participant placed in low calcium intake group (LC, $< 650$ mg/day) (LC, n=187, 77.9%) while the high calcium intake group (HC, $\geq 650$ mg/day) was only 22.1% of the participants (n=53). Those with high calcium intake had more favourable outcome expectations, higher self-efficacy in consuming calcium-rich foods, and more desirable eating behaviours than those in the LC group. - Among self-efficacy items, the perceived ability of eating dairy foods for snacks ( $p < 0.001$ ), eating dairy foods every day ( $p < 0.01$ ), and eating calcium-rich side dishes at meals ( $p < 0.05$ ) differed significantly between the HC and LC groups.
19	Elnaem et al. (2017) Malaysia	To evaluate the knowledge of osteoporosis, one of the growing health-care burdens in Malaysia, among students belonging to three different health occupations programs in a Malaysian University.	A cross-sectional study design	348 medicine, pharmacy, and allied health sciences students in a Malaysian University.	Age was not identified in the study.	Revised Osteoporosis Knowledge Test questionnaire	- The results showed variability in knowledge scores between students belonging to different study programs. - More than half of the respondents showed adequate knowledge of osteoporosis (50.6%) is almost the same as those with inadequate knowledge (49.4%). - Allied health sciences students have the highest overall knowledge score (median=20) and nutrition score (median=16). However, both students in allied health sciences and medicine programs shared a similar median score (median=11.5) for exercise score. - 69.91% of the pharmacy respondents scored below than median score.

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
20	Khan et al. (2019) Jeddah Makkah Tabuk Medina KSA	To assess awareness and knowledge of osteoporosis among young adults (18–30 years) attending Saudi universities, exploring the relationship between education, gender, and the sources of information in this age group.	A cross-sectional survey	337 students (176 females; 161 males) From faculties of: (Science; Art and Humanities; Economics and Administration; Home Medicine; Economics) In four Saudi universities: - King Abdelaziz University, Jeddah. - Umm Al-Qura University, Makkah. - Tabuk University, Tabuk. - Taibah University, Medina.	18–30 years Most students were: - Undergraduates (n=177; 52.7%), - Preparatory year (n=96; 28.6%) - Postgraduate (n=63; 18.7%).	A self-reported questionnaire was designed to assess awareness and knowledge of osteoporosis across several domains, including risk factors for the disease, prevalence, symptoms, prevention, and treatment.	- 12.2% reporting having been diagnosed with osteoporosis, 86.3 % of overall students had an average 139 (41.2%) or good 152 (45.1%) knowledge level score. - Knowledge score correlated with education ( $r^2=0.28$ ) and gender ( $r^2=0.27$ ); $p<0.0001$ . - Knowledge increased with increasing education level (preparatory year 47.8±15.3%), undergraduate (53.5±16.5%), and postgraduate (61.8±15.8%); all $p<0.0001$ . - Females were better informed than males (57.7±15.4% vs 48.8±16.8%; $p<0.0001$ ). - Among the students who had an awareness of osteoporosis, the information sources were foremost from friends (32.1%). - The majority of students (83.1%) believed that health care providers (clinics, hospitals, and health centres) do not provide adequate teaching about osteoporosis prevention.
21	Nguyen (2015) Columbia, USA	Tested an osteoporosis prevention education intervention to alter osteoporosis health beliefs and to increase osteoporosis-preventive behaviours to determine the effectiveness and make public health recommendations.	An experimental study	37 young men undergraduate college students in an undergraduate health education class Two groups: - Treatment (n=17) - Control group (n=20)	Age (years) Mean of Control (n=20) = 20.05 and Mean of Treatment (n=17) = 21.79	- Osteoporosis Health Belief Scale (OHBS). - Osteoporosis Self-Efficacy Scale (OSES), and - Exercise and Calcium Behaviours Scale (ECBS)	- Both groups had low perceived susceptibility to osteoporosis and low to moderate perceived severity of osteoporosis. - Bouts of exercise per week were adequate; however, consumption of good sources of calcium per day appeared to be low. - The study showed that the osteoporosis prevention education intervention was ineffective in altering osteoporosis health beliefs to increase preventive behaviours. It did not increase the actual osteoporosis-preventive behaviors of self-reported weight-bearing physical activity and calcium consumption ( $p>0.05$ ).
22	Ghaffari et al. (2015) Iran	To investigate the health faculty students' awareness of osteoporosis (calcium intake and physical activity).	Descriptive-analytical research	239 students in the health faculty, Shahid Beheshti University of Medical Sciences	18-24 years old	A valid and reliable questionnaire regarding the students' awareness of osteoporosis (including 9 in calcium intake and 15 others in physical activity).	Only 46 (19.2%) students had a high-level knowledge of osteoporosis, and 64% of students had an average level of knowledge.

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
23	Hervás et al. (2018) Spain	To analyze the relationship between physical activity (PA), physical fitness, body composition, and dietary intake with bone stiffness index (SI), measured by quantitative ultrasonometry in young university students.	Descriptive-analytical research	156 young adults (61 men and 95 women) recruited among different university degree programs at the University of the Basque Country (UPV/EHU).	18–21 years	- Bone Status is measured by quantitative ultrasonometry (QUS). - Anthropometrics - Dietary consumption is assessed by filling out a food record for five days. - Strength measurements of muscles and knee measured by an isokinetic dynamometer - Physical activity is measured by wearing an accelerometer	- The males' calcium intake (1018±348 mg/day) reached the recommended value, and the females' average (814±206 mg/day) was less than that recommended by the WHO (1000 mg/day) ( $p<0.001$ ). - Moderate-to-vigorous PA (MVPA) was the strongest predictor of SI ( $\beta = 0.184$ ; $p=0.035$ ). SI was most closely related with very vigorous PA in males ( $\beta=0.288$ ; $p=0.040$ ) and with the number of steps/day in females ( $\beta=0.319$ ; $p=0.002$ ). An association between thigh muscle and SI was consistent in both sexes ( $\beta=0.328$ ; $p<0.001$ ). Additionally, extension maximal force was a bone SI predictor factor in females ( $\beta=0.263$ ; $p=0.016$ ) independent of thigh muscle perimeter. - Calcium intake was the only nutrition parameter with a positive relationship with SI ( $r=0.217$ ; $p=0.022$ ).
24	Johnson et al. (2015) USA	To determine if selected predictors of BMD in African American and Caucasian college-aged women differ by race.	A prospective cohort study	101 local African American (n=50) and Caucasian (n=51) females at a Mississippi University.	Age range 18 to 30 years Mean age 21.3±2.2	- Anthropometric Assessment - Osteoporosis Knowledge Test (OKT) - A 7-day Physical Activity Recall Questionnaire - Record of food intake over the next four days. - Bone Mineral Density Assessment using the dual-energy x-ray absorptiometry (DXA)	- Participants in this study had a higher prevalence of low spinal BMD (38.6%) than low femoral BMD (7.9%). - 26.7% of participants met the Recommended Dietary Allowance (RDA) for calcium. - Less than one-quarter of 21.8% of the participants met physical activity requirements. Furthermore, one-third (33.7%) of this sample reported no physical activity. - BMI ( $p=0.001$ , $p=0.010$ ) and current physical activity ( $p=0.017$ , $p=0.007$ ) were the only variables that were statistically significant in predicting spinal and femoral BMD respectively. The race was not a significant predictor of spinal or femoral BMD. - 43.6% of individuals classified as having a low weight also had low spinal BMD, and 75% of those with a low weight had low femoral BMD.
25	Lim et al (2018) Korea	To measure the bone mineral density (BMD) of college students and to analyse differences in BMD according to lifestyle.	A cross-sectional survey	161 (68 male and 93 female). college students from Soonchunhyang University	Mean age of males (22.5±3.0) and females (21.1±2.8).	- The BMD was measured using quantitative ultrasonography QUS-2 - Survey for the general information, lifestyle, regular exercise, and eating habits - Data on dietary intake were collected using the 24-hr recall method for three days.	- The result showed that 8.8% of males and 10.8% of females were classified as osteopenia. - Calcium intake was higher in male college students (575.2±282.2) than in females (428.1±5,308.7), but there was no significant difference in calcium intake between the two groups. However, still, both groups were below the RDA. - 77.9% from male students (n=53) and 88.2% from the female student (n=82) not engaging in regular exercise - Male college students who are smoking $p=0.003$ and all college students who frequently eat fast food had significantly lower BMD (male $p<0.001$ , female $p<0.015$ ).

No.	Authors	Study objective	Study design	Sample	Age	Data collection	Finding
26	Kim et al. (2016) Korea	To investigate the relationship between bone-specific physical activity (BPAQ) scores, body composition, and bone mineral density (BMD) in healthy young college women.	Cross-sectional study	73 college students from the universities in Seoul and Gyeonggi province, South Korea.	Range between the ages of 19 and 26 years	- Body composition - Bone Mineral Density using DXA - 24-hour food intake recall - Bone-specific Physical Activity Questionnaire (BPA)	- 24.7% and 27.4% of the participants were classified as osteopenia FN and L2-L4, respectively. - Also, the participants showed lower calcium (432.3±236.7 mg) and vitamin D intake (3.7±3.9 mcg), which did not meet the RDA for calcium (1000 mg/day) and vitamin D intake (15 mcg/day) - The BPAQ scores (past, pBPAQ; current, cBPAQ; total, tBPAQ) were used to obtain a comprehensive account of lifetime physical activity related to bone health. The result indicates that the bones-specific physical activity (BPAQ) scores were positively related to total hip (past BPAQ $r=0.308$ , $p=0.008$ ; total BPAQ, $r=0.286$ , $p=0.014$ ) and Femoral Neck (FN) BMD (pBPAQ $r=0.309$ , $p=0.008$ ; tBPAQ, $r=0.311$ , $p=0.007$ ) and no correlations were detected in lumbar spine (L2-L4). While no significant relationships were found in current BPAQ ( $p>0.05$ ). Beside there was a positive correlation between vitamin D intake and L2-L4 ( $p=0.025$ ), but other dietary intakes variables were not significant ( $p>0.05$ ).
27	Way (2016) US	To determine the impact of a teaching module about osteoporosis prevention and treatment on nurse practitioner students' awareness and knowledge by providing an online PowerPoint (PPT) presentation: One with voice enhancement and one without voice.	Quantitative non-experimental descriptive pretest/post-test design	18 nursing students from the Wilmington University nurse practitioner program. Group 1: Voice-enhanced PowerPoint presentation (n=8) Group 2: Non-voice PowerPoint presentation (n=10)	Ages ranged from 26–55.	Osteoporosis Knowledge Test (OKT)	- The voice-enhanced PPT presentation significantly improved the total knowledge scores ( $p=0.002$ ). The exercise and nutrition subscale also showed in significant improvement ( $p=0.01$ and $p=0.002$ , respectively). - For the non-voice presentation group, the participants demonstrated a non-significant improvement (although nearly significant) in total assessment scores ( $p>0.054$ ). The improvement was again statistically non-significant ( $p=0.093$ ) for the exercise subscale but was significant for the nutrition subscale scores ( $p=0.023$ ).