Archives of Osteoporosis (2019) 14:8
https://doi.org/10.1007/s11657-019-0560-y

ORIGINAL ARTICLE

Osteoporosis knowledge and awareness among university students in Saudi Arabia

Jalaluddin A. Khan[1,2] · Fiona E. McGuigan[3,4] · Kristina E. Akesson[3,4] · Y. M. Ahmed[1,5] · Faiza Abdu[5] · Hussam Rajab[6] · Mai Albaik[1,2]

Received: 16 November 2018 / Accepted: 6 January 2019

Abstract

Summary Awareness and knowledge about any disease is the first step to prevent and treat it, so this study evaluates osteoporosis awareness and knowledge in university students. Our results showed a high awareness and good knowledge of osteoporosis. Females were better informed than males. Knowledge increased with increasing education level.

Purpose Osteoporosis is a worldwide health problem, including Saudi Arabia where vitamin D deficiency is common. Prevention of osteoporosis must begin by increasing awareness of the disease from a young age. This study aimed to assess awareness and knowledge of osteoporosis among young adults (18–30 years) attending Saudi universities, exploring the relationship between education and gender and the sources of information in this age group.

Methods A cross-sectional survey was conducted in 337 students (176 females; 161 males) randomly selected from four Saudi universities during January–December 2017. Education level ranged from preparatory year to undergraduate and postgraduate levels. 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.

Results Overall, 92% of students had some awareness of osteoporosis through a variety of sources, predominantly via friends. Just over half of all students had a good or high knowledge level overall (53.4 ± 16.6%). Knowledge score correlated with education ($r^2 = 0.28$) and gender ($r^2 = 0.27$); $p < 0.0001$. Females were better informed than males (57.7 ± 15.4% vs 48.8 ± 16.8%; $p < 0.0001$). Knowledge increased with increasing education level (preparatory year (47.8 ± 15.3%), undergraduate (53.5 ± 16.5%), and postgraduate (61.8 ± 15.8%); all $p < 0.0001$).

Conclusion Knowledge of osteoporosis was good among university students in Saudi Arabia, higher in females and with increasing years of education. Overall, students were more knowledgeable about risk factors compared to other aspects such as symptoms, prevention, or treatment of osteoporosis.

Keywords Osteoporosis · Awareness · Knowledge · University · Students · Saudi Arabia

✉ Mai Albaik
beikmai@gmail.com

[1] Biochemistry Department, Faculty of Science, King Abdulaziz University, P.O. Box 80203, Jeddah 21589, Saudi Arabia

[2] Center of Excellence for Osteoporosis Research, King Fahd Medical Research Center, King Abdulaziz University, P.O. Box 80216, Jeddah 21589, Saudi Arabia

[3] Department of Clinical Sciences Malmö, Clinical and Molecular Osteoporosis Research Unit, Lund University, Lund, Sweden

[4] Department of Orthopaedics, Skåne University Hospital, Malmö, Sweden

[5] Department of Biological Science, Faculty of Science, King Abdulaziz University, P.O. Box 42699, Jeddah 21551, Saudi Arabia

[6] English Language Institute, Faculty of Arts and Humanities, King Abdulaziz University, P.O. Box 80200, Jeddah 21589, Saudi Arabia

Published online: 14 January 2019

Introduction

Osteoporosis is a metabolic, systemic skeletal disorder characterized by low bone density and micro-architectural deterioration causing bone fragility and increased risk of fractures as a result of even minor falls or injuries [1]. Osteoporosis-related fractures commonly occur in the hip, wrist, or spine [2].

The World Health Organization (WHO) defines osteoporosis as "an epidemic of the twenty-first century" together with obesity, diabetes, and cardiovascular disease [3], contributing to mortality and morbidity among the elderly [4–6]. Despite its adverse effects, osteoporosis is often overlooked and undertreated [7, 8] and worldwide, public awareness of osteoporosis is low [9].

Osteoporosis is estimated to affect over 200 million people worldwide [10]. In Saudi Arabia, its prevalence is estimated at 34–39.5% of women aged 50–80 years and 21.4–30.7% of healthy men [11, 12]. Despite adequate sunshine, vitamin D deficiency is common in Saudi Arabia in children and adults [13–15], explained in part by genetic differences [16] and limited sun exposure as a consequence of the requirement for clothing to cover the skin.

Raising awareness of osteoporosis among the general population and health care workers is an important step in its prevention and treatment and improving the quality and accessibility of health services [11, 17–19]. Targeting awareness in young adults is one way to safeguard their bone health later in life. Increased awareness of the disease may also translate into greater awareness for older, at risk, family members.

Although osteoporosis education programs have been implemented in the Middle East to improve knowledge and awareness among the public, these have had limited success in changing beliefs and behaviors [20]. In Saudi Arabia, there has been little attention given to address the level of awareness of osteoporosis among the public [17].

This study aims to characterize the awareness of osteoporosis risk factors, symptoms, and treatment among Saudi university students; in order to explore the relationship between education, gender, and osteoporosis awareness. A secondary aim is to understand the sources young adults obtain their information.

Subjects and methodology

Participants

This cross-sectional survey was conducted on students aged 18–30 years, randomly selected from assorted faculties (Science; Art and Humanities; Economics and Administration; Medicine; Home Economics) in four Saudi universities [King Abdulaziz University, Jeddah; Umm Al-Qura University, Makkah; Tabuk University, Tabuk; Taibah University, Medina] during January to December 2017. Students were randomly selected in the college lobby and recruited across preparatory, undergraduate, and postgraduate levels. Of the 366 initially agreeing to participate, a final total of 337 students who completed the questionnaire were included in the analyses.

A sample size of 300 respondents to the survey was judged sufficient to give 90% power (calculated using checkmarket (https://www.checkmarket.com/sample-size-calculator/).

Ethical approval was obtained from the Research Unit, English Language Institute, King Abdulaziz University, Jeddah, Saudi Arabia.

Data collection tool

A questionnaire containing 39 questions was designed and developed from previous studies [11, 17, 21–23], with a content validity of 0.95 and reliability of 0.96. The self-administered questionnaire collected data on sociodemographic and lifestyle and nutrition and health (including self-reported personal or family history of osteoporosis and fracture).

Twenty-eight questions (listed in Tables 3 and 4) were developed to assess the students' knowledge of osteoporosis across several domains, including risk factors for the disease [aging (1 question), genetics (1 question), race (1 question), skin color (2 questions), vitamin D deficiency (1 question), low sun exposure (1 question), diet (4 questions), smoking (1 question), hormonal activity (4 questions), drugs (2 questions)], as well as prevalence (1 question), symptoms (3 questions), prevention (4 questions), and treatment (2 questions)].

Response options included "agree," "disagree," or "do not know." A score was created by assigning "1" to each correct answer and "0" to each incorrect or unsure answer. The number of correct answers was summed (range 0–28) and knowledge level was stratified into four categories: poor (0–7 correct answers, 0–25%), average (8–14 correct answers, 26–50%), good (15–21 correct answers, 51–75%), and high (22–28 correct answers, 76–100%).

Information was also collected regarding the sources (hospitals/clinics, TV/satellite channel, Internet, newspapers, friends, and health ministry/universities) from which the students acquired their information on osteoporosis. For each source, the response options included "yes," "no," or "do not remember."

Statistical analysis

Data was analyzed using IBM SPSS statistics® version 22.

Descriptive statistics are reported as frequencies and percentage. Independent *t* test was used to identify differences between genders; ANOVA was utilized to test for differences between educational levels. Pearson's correlation was applied

Table 1 Demographic characteristics of the participating students

	Overall $n = 337$	Female $n = 176$	Male $n = 161$	p value*
Education				
Preparatory	96 (28.6%)	26 (14.8%)	70 (43.8%)	
Undergraduate	177 (52.5%)	111 (63%)	66 (41.2%)	0.0001
Postgraduate	63 (18.7%)	39 (22.2%)	24 (15%)	
BMI (kg/m^2)	23.8 ± 5.4	22.6 ± 4.3	25.1 ± 6	0.0001
No. Obese (BMI ≥ 25)	106 (33.8%)	40 (37.7%)	66 (62.3%)	0.0001
No. with osteoporosis	41 (12.2%)	25 (14.2%)	16 (9.9%)	0.233
No. with a fracture	72 (21.4%)	27 (15.3%)	45 (28%)	0.005
No. taking calcium or vitamin D supplements	115 (34.1%)	84 (47.7%)	31 (19.3%)	0.0001

Values are number (%) except BMI which is presented as mean ± SD. *T test. Comparing differences between males and females

to determine the relationship between osteoporosis knowledge, gender, and education. P values of < 0.05 were considered nominally significant.

Results

Descriptives of the participants

A total of 337 students completed the questionnaire (176 females (52.2%) and 161 males (47.8%), their age ranged between 18 and 30 yrs. The majority of students were undergraduates ($n = 177$; 52.7%), followed by preparatory year ($n = 96$; 28.6%) and postgraduate ($n = 63$; 18.7%). A total of 72 (21.4%) students reported having suffered a fracture sometime in the past, with 12.2% reporting having been diagnosed with osteoporosis and 34.1% taking calcium and vitamin D supplementation. More than one third of the participants ($n = 123$; 37.2%) reported having a family member with osteoporosis (47.3% direct family; 52.7% distant relatives). Table 1.

Awareness and knowledge of osteoporosis

Awareness of osteoporosis was evaluated by asking participants if they have previously heard or known about osteoporosis. The majority answered yes (92%) and awareness was similar between females and males (f—174/m—158). Among those approached, 29 had not heard of osteoporosis prior to participating in the study (3 females/ 20 males) or did not remember having heard (1 female/5 males). These individuals are not included in the final analyses of knowledge of risk factors and other aspects of osteoporosis.

Just over half of all students had a good or high knowledge overall level about osteoporosis (Table 2A), and women were generally more knowledgeable than men (57.7 ± 15.4% and 48.8 ± 16.8%, respectively) at $p < 0.0001$. With increasing level of secondary education, knowledge also increased-from average among those in preparatory year (47.8 ± 15.3%), to good among undergraduate (53.5 ± 16.5%) and postgraduate students (61.8 ± 15.8%), $p < 0.0001$. There was no difference between those who had or had not suffered a fracture, but those with a family history of osteoporosis had a higher score than those without (~ 5

Table 2 Knowledge of osteoporosis among students (A) by gender and (B) by history of fracture or osteoporosis

(A)	Overall $n = 337$	Female $n = 176$	Male $n = 161$	p value
Overall knowledge	53.4 ± 16.6%	57.7 ± 15.4%	48.8 ± 16.8%	0.0001*
Knowledge level				
Poor (0–25%)	19 (5.6%)	6 (3.4%)	13 (8.1%)	0.0001**
Average (26–50%)	139 (41.2%)	55 (31.3%)	84 (52.2%)	
Good (51–75%)	152 (45.1%)	98 (55.7%)	54 (33.5%)	
High (76–100%)	27 (8%)	17 (9.7%)	10 (6.2%)	

(B)	Previously fractured			Family history of osteoporosis		
	Yes ($n = 72$)	No ($n = 264$)	p value*	Yes ($n = 123$)	No ($n = 173$)	p value*
Overall knowledge	51.7 ± 16.2	53.8 ± 16.8	0.343	57.1 ± 15.5	51.3 ± 17.2	0.003

The percentage of overall knowledge is presented as mean ± SD. *T test; **ANOVA

Table 3 Knowledge of RISK FACTORS for osteoporosis by (A) gender and (B) educational level

Risk factors	Question asked	A		*p* value*	B			*p* value**
		Number (%) correctly answering each question			Number (%) correctly answering each question			
		Female ($n = 176$)	Male ($n = 161$)		Preparatory ($n = 96$)	Undergraduate ($n = 177$)	Postgraduate ($n = 63$)	
Aging	Aging increases the chance of developing osteoporosis	161 (93.6%)	132 (83%)	0.002	79 (85.9%)	152 (86.9%)	61 (96.38%)	0.068
Genetics	Heredity plays a role in susceptibility to osteoporosis	69 (39.2%)	65 (40.9%)	0.755	28 (29.8%)	75 (42.4%)	31 (49.2%)	0.035
Race	• Race and ethnicity plays a role in susceptibility to osteoporosis	33 (19.2%)	33 (20.8%)	0.742	16 (17.4%)	26 (14.9%)	24 (38.7%)	0.0001
Skin color	• Skin color plays a role in developing osteoporosis	23 (13.4%)	24 (15.1%)	0.655	7 (7.6%)	24 (13.7%)	16 (25.4%)	0.007
	• People with white skin color are more susceptible to osteoporosis than others	18 (10.5%)	28 (17.6%)	0.064	13 (14.3%)	24 (13.7%)	9 (14.3%)	0.989
Vitamin D deficiency	Vitamin D deficiency leads to developing osteoporosis	157 (91.3%)	118 (75.2%)	0.0001	69 (75.8%)	148 (84.6%)	57 (91.9%)	0.026
Low sun exposure	Lack of adequate sun exposure may increase the chance of developing osteoporosis	163 (94.8%)	130 (82.3%)	0.0001	80 (87.9%)	156 (89.1%)	56 (88.9%)	0.955
Diet	• Drinking fizzy drinks increases the risk of developing osteoporosis	169 (96%)	150 (93.8%)	0.344	94 (98.9%)	170 (96%)	54 (85.7%)	0.001
	• Drinking alcohol increases the risk of developing osteoporosis	150 (85.2%)	100 (63.3%)	0.0001	69 (72.6%)	135 (77.1%)	45 (71.4%)	0.572
	• Drinking coffee increases the risk of developing osteoporosis	74 (42%)	35 (22%)	0.0001	23 (24.2%)	62 (35.2%)	24 (38.1%)	0.108
	• High salt (table salt) intake increases the risk of developing osteoporosis	27 (15.4%)	25 (15.7%)	0.941	14 (14.9%)	24 (13.6%)	14 (22.6%)	0.238
Smoking	Smoking increases the risk of developing osteoporosis	94 (53.4%)	70 (43.8%)	0.077	45 (47.4%)	82 (46.3%)	37 (58.7%)	0.225
Hormonal effects	• Pregnancies increase the chance of developing osteoporosis	124 (72.1%)	71 (44.7%)	0.0001	37 (40.2%)	106 (60.6%)	51 (81%)	0.0001
	• Menopause in women can increase a women's risk of developing osteoporosis	113 (65.7%)	72 (45.6%)	0.0001	41 (45.1%)	92 (52.6%)	52 (82.5%)	0.0001
	• Thyroid related diseases increase the chance of developing osteoporosis	44 (25.6%)	31 (19.6%)	0.198	16 (17.4%)	35 (20%)	24 (38.7%)	0.003
	• Hormonal factors play a role in developing osteoporosis	56 (32.6%)	63 (39.9%)	0.168	28 (30.4%)	57 (32.8%)	34 (54%)	0.004
Drugs	• Taking certain drugs may increase the chance of developing osteoporosis.	71 (41.3%)	53 (34.6%)	0.220	25 (27.2%)	63 (37.3%)	36 (57.1%)	0.001
	• Chemotherapy treatment may increase the chance of developing osteoporosis	79 (45.9%)	56 (35.2%)	0.048	27 (29.3%)	76 (43.3%)	32 (50.8%)	0.017

Data is presented as the number (%) correctly answering each question. **T* test; ***ANOVA*

percentage points higher; $p < 0.001$) Table 2B. Correlations were moderate and significant between knowledge score and gender ($r^2 = 0.27$) and education ($r^2 = 0.28$), $p < 0.0001$.

Knowledge of risk factors for osteoporosis are reported in Table 3. Females tended to be better informed than males, and higher education level was associated with greater knowledge of osteoporosis. A high percentage of students (75–95%) were aware that factors such as age, vitamin D deficiency, and low sun exposure increased the risk of osteoporosis, but only around half recognized that smoking was a risk factor.

Knowledge related to prevalence, symptoms, prevention and treatment of osteoporosis are reported in Table 4. As before, females were generally more knowledgeable than men, particularly in terms of prevalence and symptoms ($p \leq 0.001$), while education level appeared to be less relevant.

Sources of information on osteoporosis

Among the students who had an awareness of osteoporosis, the information sources were foremost from friends (32.1%), TV/satellite channels (21.3%), and

Table 4 Knowledge of other aspects of osteoporosis by (A) gender and (B) educational level

Domains	Questions	A		*p* value*	B			*p* value**
		Number (%) correctly answering each question			Number (%) correctly answering each question			
		Female (*n* = 176)	Male (*n* = 161)		Preparatory (*n* = 96)	Undergraduate (*n* = 177)	Postgraduate (*n* = 63)	
Prevalence	Osteoporosis is a common disease in Saudi Arabia	134 (77.9%)	64 (40.3%)	0.001	45 (48.9%)	111 (63.4%)	41 (65.1%)	0.45
Symptoms	• Sustaining bone fractures is related to osteoporosis	108 (61.4%)	68 (42.8%)	0.001	46 (48.4%)	91 (51.4%)	39 (62.9%)	0.183
	• Back pain, difficulties in walking and sustaining bone fractures are all signs of developing osteoporosis	136 (79.1%)	103 (64.8%)	0.004	56 (60.9%)	135 (77.1%)	48 (76.2%)	0.014
	• Osteoporosis can affect dental health and cause teeth to fall out	122 (70.9%)	75 (47.2%)	0.0001	45 (48.9%)	108 (61.7%)	44 (69.8%)	0.24
Prevention	• Drinking tea protects from osteoporosis	25 (14.2%)	16 (10.1%)	0.258	7 (7.4%)	21 (11.9%)	13 (21%)	0.041
	• Regulating dietary habits has a role in preventing osteoporosis	154 (88%)	135 (84.9%)	0.41	80 (85.1%)	152 (86.4%)	56 (88.9%)	0.793
	• Having dairy products plays a role in preventing osteoporosis	160 (91.4%)	140 (87.5%)	0.242	84 (88.4%)	158 (89.3%)	57 (91.9%)	0.773
	• Breast feeding helps decrease the chance of developing osteoporosis in babies in the future	128 (74.4%)	102 (65%)	0.62	61 (66.3%)	124 (71.3%)	45 (72.6%)	0.631
Treatment	• Sports help maintain healthy bones and prevents problems that would happen from osteoporosis	153 (89%)	139 (87.4%)	0.667	86 (92.5%)	151 (86.8%)	54 (85.7%)	0.313
	• There is a treatment for osteoporosis	96 (55.8%)	101 (63.5%)	0.154	45(69.6%)	108 (54.3%)	44 (58.7%)	0.054

Data is presented as the number (%) correctly answering each question. **T* test; ***ANOVA*

Internet (19.7%). Although 17.5% had obtained information from hospitals/clinics, fewer than 5% reported pamphlets from the health ministry or university health centers as a source. Similarly, newspapers were an infrequent basis of information (Fig. 1). The majority of students (83.1%) believed that health care providers

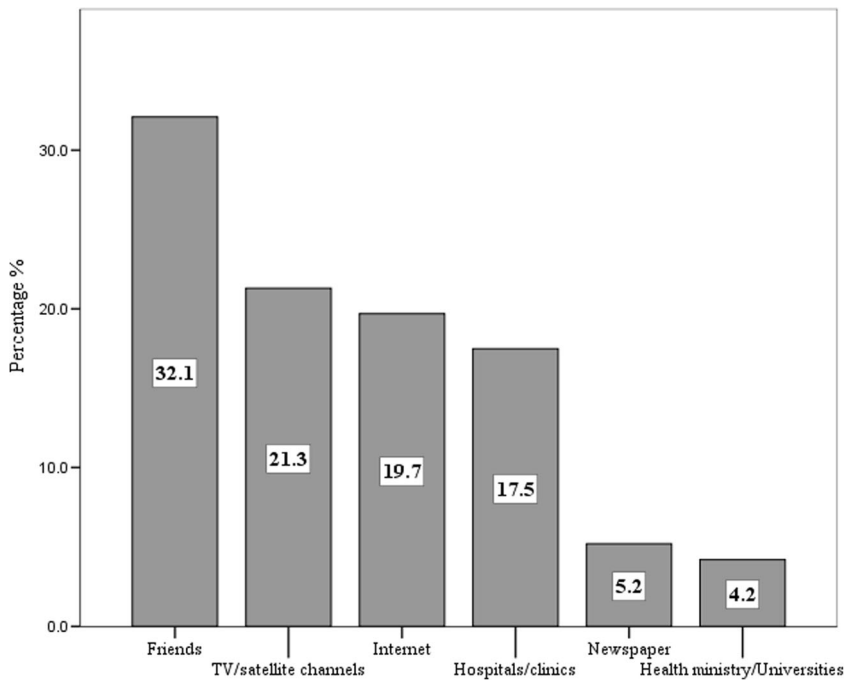

Fig. 1 The information sources regarding osteoporosis for Saudi university students. Students reported their primary sources of information of osteoporosis

(clinics, hospitals, and health centers) do not provide adequate teaching about osteoporosis prevention.

Discussion

The numbers suffering from osteoporosis are expected to rise significantly in the next decade [24–26], exacerbating an already substantial health problem [17]. Increasing public awareness of osteoporosis and its clinical consequence of fracture is one of the challenges facing care providers [9, 27]. In Saudi Arabia, the cost of osteoporosis-related femoral fractures is estimated at $1.14 billion per year [28], and since prevention may be one of the most cost-effective strategies, it is important that the challenge of increasing osteoporosis awareness is met. Young adults are an important demographic to target in order to reduce the future burden of disease, therefore in this study, performed in Saudi Arabia where osteoporosis and vitamin D deficiency is prevalent, we evaluated osteoporosis awareness and knowledge in young adults in tertiary education.

Encouragingly, given the low awareness worldwide, in the current study, we found that participants of both sexes had overall, a high awareness of osteoporosis (92%). While this may be explained by their higher education status, in an observational, cross-sectional study conducted in Riyadh, Saudi Arabia, by Barzanji et al. 87.5% of adults representing the general population of the city had heard of osteoporosis [1]. This compares favorably with other countries; a study in Vietnam found that approximately 82% of the women had heard of osteoporosis [22], while another survey reported that only 49.5% of young Thai women had some knowledge of the disease [23].

In the present study, knowledge scores across the tested domains ranged between 11 and 100%, with overall just over half scored as having an average knowledge of osteoporosis. This is consistent with results from studies in the USA and China, albeit from 7 years ago [21], with other studies in Saudi Arabia documenting 56.6 and 64.4% [11, 17].

Knowledge of osteoporosis was correlated with educational level even at this tertiary level, in an already educated population, consistent with what has previously been reported [11, 29, 30]. Although not feasible here, it would be interesting to explore in a larger study the relationship with specific academic disciplines, whether scientific or literary.

Females had a greater knowledge of osteoporosis (58%) than males (49%), which is in agreement with other studies, and likely explained by their perceived higher susceptibility to the disease [11, 21]. In an American study, male students were reportedly "not concerned" by the disease [21]. It is a common misconception that osteoporosis affects only women [11] and the media frequently presents osteoporosis as a female disease which may influence the finding that in the USA females have a greater sense of susceptibility than males do [17]. Further studies into the influence of media on osteoporosis knowledge and perceptions within and between genders are warranted [17].

Interestingly, knowledge across the domains tested was varied; risk factors were, in general, better understood than the prevalence, signs and symptoms, and prevention and treatment, reflecting that young people are less concerned with future disease status. This trend is also seen in other studies, where risk factors for osteoporosis were recognized by 80% of the participants [17, 31]. Whether this translates to altered behavior and good bone health practices, however, is unknown. We also found that, while students who had a family history of osteoporosis were better informed about osteoporosis [11], no association between personal-fracture history and knowledge score was apparent, although this should be interpreted cautiously since detailed information on fracture age or cause was not known.

One of our aims was to understand the sources of information for osteoporosis. It is clear from this study that dissemination of information needs to be targeted appropriately for the young compared to older adults. Literature provided by the health ministry or university health care was the least common information source and friends the highest. Puttapitakpong et al. reported similar results in Thailand, with only 30% receiving information from a doctor, nurse, or midwife [2]. While recognizing the advantage of easy dissemination of information through social media, not all such information, even in traditional media may be accurate [11]. With this in mind, for this age group, it may be better to convey information about osteoporosis through appropriate media attuned with their lifestyle and interests [23]. These observations highlight the need to address the gaps in osteoporosis knowledge among health care professionals to deliver information where it is needed; otherwise, opportunities to disseminate information to young women may be lost or information not appropriately received and retained [23].

In conclusion, knowledge of osteoporosis was found to be good among university students in Saudi Arabia, higher in females, and with increasing years of tertiary education. Overall, students were more knowledgeable about the risk factors compared to other aspects such as symptoms, prevention, or treatment of osteoporosis.

Acknowledgments This project was funded by the Deanship of Scientific Research (DSR) at King Abdulaziz University, Jeddah, under grant no. (G-646-130-38). The authors, therefore, acknowledge with thanks DSR for technical and financial support. Thanks are extended to Neuroscience Unit at King Fahd Medical Research Center for their support and facilities. Special thanks for Dr. Khaled AlQahtani, the director of Deryaq polyclinic, for his support and comments.

Funding support This project was funded by Deanship of Scientific Research (DSR), King Abdulaziz University, Jeddah, grant no. (G-646-130-38).

Compliance with ethical standards

Conflict of interest None.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. Consensus N (2001) Development panel on osteoporosis prevention, diagnosis and therapy. JAMA 28:785–795
2. Harvey N, Dennison E, Cooper C (2010) Osteoporosis: impact on health and economics. Nat Rev Rheumatol 6:99–105
3. WHO Scientific Group on Prevention, Management of Osteoporosis, WHO (2003) Prevention and management of osteoporosis: report of a WHO scientific group (WHO technical report series; 921). http://www.who.int/iris/handle/10665/42841. Accessed 12 Dec 2018
4. Trombetti A, Herrmann F, Hoffmeyer P, Schurch M, Bonjour J-P, Rizzoli R (2002) Survival and potential years of life lost after hip fracture in men and age-matched women. Osteoporos Int 13:731–737
5. von Friesendorff M, McGuigan FE, Wizert A, Rogmark C, Holmberg AH, Woolf AD, Akesson K (2016) Hip fracture, mortality risk, and cause of death over two decades. Osteoporos Int 27:2945–2953
6. Bliuc D, Center JR (2016) Determinants of mortality risk following osteoporotic fractures. Curr Opin Rheumatol 28:413–419
7. Åkesson K, Mitchel P (2012) Capture the fracture: a global campaign to break the fragility fracture cycle. International Osteoporosis Foundation, Nyon
8. Hernlund E, Svedbom A, Ivergård M, Compston J, Cooper C, Stenmark J, McCloskey EV, Jönsson B, Kanis JA (2013) Osteoporosis in the European Union: medical management, epidemiology and economic burden. Arch Osteoporos 8:136
9. Harvey NC, McCloskey EV, Mitchell PJ, Dawson-Hughes B, Pierroz DD, Reginster J-Y, Rizzoli R, Cooper C, Kanis JA (2017) Mind the (treatment) gap: a global perspective on current and future strategies for prevention of fragility fractures. Osteoporos Int 28:1507–1529
10. Tomishige-Mukai E, Kawachi A, Kiyohara E, Esaki F, Sonoda J, Shinya T, Narumi K, Sato K, Motoya T (2016) Instructing students to measure their own bone density and prepare a simulated health class during pharmacy school improves their awareness and understanding of osteoporosis prevention. J Pharm Health Care Sci 2:11
11. Barzanji AT, Alamri FA, Mohamed AG (2013) Osteoporosis: a study of knowledge, attitude and practice among adults in Riyadh, Saudi Arabia. J Community Health 38:1098–1105
12. Alwahhabi BK (2015) Osteoporosis in Saudi Arabia: are we doing enough? Saudi Med J 36:1149–1150
13. Tuffaha M, El Bcheraoui C, Daoud F, Al Hussaini HA, Alamri F, Al Saeedi M, Basulaiman M, Memish ZA, AlMazroa MA, Al Rabeeah AA (2015) Deficiencies under plenty of sun: vitamin D status among adults in the kingdom of Saudi Arabia, 2013. N Am J Med Sci 7:467
14. Albaik M, Khan J, Iyer A (2016) Vitamin D status in Saudi population: a mini review. Indian J Endocrinol Metab 6:629–632
15. Green RJ, Samy G, Miqdady M, El-Hodhod M, Akinyinka O, Saleh G, Haddad J, Alsaedi S, Mersal A, Edris A (2015) Vitamin D deficiency and insufficiency in Africa and the Middle East, despite year-round sunny days. S Afr Med J 105:603–605
16. Binkley N, Novotny R, Krueger D, Kawahara T, Daida YG, Lensmeyer G, Hollis BW, Drezner MK (2007) Low vitamin D status despite abundant sun exposure. J Clin Endocrinol Metab 92:2130–2135
17. Saeedi MY, Al-Amri F, Mohamed A, Ibrahim AK (2014) Knowledge, attitude and practice towards osteoporosis among primary health care physicians in Riyadh, Saudi Arabia. Science Journal of Public Health (SJPH) 2:624–630
18. Aree-Ue S, Petlamul M (2013) Osteoporosis knowledge, health beliefs, and preventive behavior: a comparison between younger and older women living in a rural area. Health Care Women Int 34:1051–1066
19. Alamri FA, Saeedi MY, Mohamed A, Barzanii A, Aldayel M, Ibrahim AK (2015) Knowledge, attitude, and practice of osteoporosis among Saudis: a community-based study. J Egypt Public Health Assoc 90:171–177
20. Abushaikha L, Omran S, Barrouq L (2009) Osteoporosis knowledge among female school students in Jordan. East Mediterr Health J 15:906–911
21. Ford MA, Bass M, Zhao Y, Bai J-B, Zhao Y (2011) Osteoporosis knowledge, self-efficacy, and beliefs among college students in the USA and China. J Osteoporos 2011:1–8
22. Nguyen NV, Dinh TA, Ngo QV, Tran VD, Breitkopf CR (2015) Awareness and knowledge of osteoporosis in Vietnamese women. Asia Pac J Public Health 27:NP95–N105
23. Puttapitakpong P, Chaikittisilpa S, Panyakhamlerd K, Nimnuan C, Jaisamrarn U, Taechakraichana N (2014) Inter-correlation of knowledge, attitude, and osteoporosis preventive behaviors in women around the age of peak bone mass. BMC Womens Health 14:35
24. Becker DJ, Kilgore ML, Morrisey MA (2010) The societal burden of osteoporosis. Curr Rheumatol Rep 12:186–191
25. Curran D, Maravic M, Kiefer P, Tochon V, Fardellone P (2010) Epidemiology of osteoporosis-related fractures in France: a literature review. Joint Bone Spine 77:546–551
26. International Osteoporosis Foundation (2013) The Middle East & Africa regional audit: epidemiology, costs & burden of osteoporosis in 2011 https://www.iofbonehealth.org/data-publications/regional-audits/middle-east-africa-audit. Accessed 12 Dec 2018
27. Alghamdi MA, Mohammed AGA (2018) Knowledge and awareness of osteoporosis among Saudi physicians and nurses: a cross-sectional study. Open Access Maced J Med Sci 6:913
28. Bubshait D, Sadat-Ali M (2007) Economic implications of osteoporosis-related femoral fractures in Saudi Arabian society. Calcif Tissue Int 81:455–458
29. Etemadifar MR, Nourian SM, Fereidan-Esfahani M, Shemshaki H, Nourbakhsh M, Zarezadeh A (2013) Relationship of knowledge about osteoporosis with education level and life habits. World J Orthop 4:139–143
30. Van Minh H, Byass P, Wall S (2010) Multilevel analysis of effects of individual characteristics and household factors on self-rated health among older adults in rural Vietnam. Geriatr Gerontol Int 10:209–215
31. Al-Musa H, Alassmi M, AlMoria A, Alghamdi H, Alfaifi S (2013) Knowledge, practice and barriers in management of osteoporosis. Biomed Res 24:429–434