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Research Article
Osteoporosis, Osteopenia and Their Associated Risk Factors among Saudi Males

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Abstract

Background and Objective: The majority of studies worldwide, including in Saudi Arabia, have investigated low bone mineral density (BMD) and its associated risk factors in postmenopausal women. The objectives of the current study were as follows: (1) To assess the prevalence of osteopenia and osteoporosis among Saudi men aged 50 years and older and (2) To investigate the factors associated with osteoporosis and osteopenia. **Materials and Methods:** This cross-sectional study included 1,022 Saudi men aged 50 years and older. Participants were interviewed using a structured questionnaire that assessed sociodemographic and lifestyle factors. Anthropometric parameters and biomarkers were measured. Bone densitometry was assessed using dual X-ray absorptiometry (DEXA) to measure BMD levels. **Results:** The prevalence of osteopenia was 40.7% and the prevalence of osteoporosis was 9.3%. Based on the multi variable multinomial regression model, the factors that were significantly associated with osteopenia included low educational level and low body mass index (BMI), while the factors that were significantly associated with osteoporosis included old age, low BMI, smoking and a family history of fragility fractures. **Conclusion:** Low bone mass is prevalent among Saudi men and is associated with age, education, BMI, smoking and a family history of fragility fractures. Increasing the awareness of osteopenia, osteoporosis and their associated risk factors through education and community programmes will be essential in preventing the development of osteopenia and osteoporosis in the elderly population.

Key words: Osteoporosis, osteopenia, bone mineral density, body mass index

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The global burden of low bone mineral density (BMD) is increasing worldwide. Low BMD is a leading cause of morbidity and mortality in elderly people and causes one-third of fall-related deaths[1]. However, this burden only partially represents the true burden of osteoporosis, which is expected to be greater than current estimates[1]. The majority of studies worldwide, including those in Saudi Arabia, that have investigated low BMD and its risk factors have focused on postmenopausal women. Although low BMD is less common in men than in women[2], the mortality rate that is associated with hip fractures, vertebral and other major fractures as a result of osteoporosis is higher in men than in women[3-5].

Several risk factors are reportedly associated with osteoporosis. A meta-analysis of 55 observational studies investigating osteoporosis in men revealed that low body mass index (BMI), excessive alcohol intake, current smoking, chronic corticosteroid use, a history of prior fractures, a history of falls within the past year, hypogonadism, a history of cerebrovascular accidents and a history of diabetes were significantly associated with low bone density-related fractures in men[6]. Low levels of physical activity have also been associated with bone loss[7]. Additionally, body weight is associated with bone density in older men and weight loss increases the rate of hipbone loss, even in obese men undergoing voluntary weight reduction[8].

Several studies in Saudi Arabia have focused on osteoporosis and its risk factors in the male population. One study that was conducted at King Fahd Hospital at the University in Al-Khobar showed that approximately 24% of 115 male patients (aged 50-76 years) had osteoporosis and that 64% had osteopenia, based on hip scans; the same study showed that approximately 37% had osteoporosis and that 34% had osteopenia, based on lumbar spine scans[9]. A study conducted among 429 Saudi males (aged 30-90 years) at King Khalid University Hospital in Riyadh revealed that approximately 36% had osteopenia and that 21% had osteoporosis in the lumbar spine; the same study showed that 38% had osteopenia and that 11% had osteoporosis in the femoral neck. Furthermore, individuals aged 50 years and older had osteopenia or osteoporosis more frequently than individuals who were younger than 50 years[10].

As the Saudi population ages and the number of elderly patients with fractures increases, the impact on health care budgets is expected to be immense[11]. Only a few studies in Saudi Arabia have focused on low BMD and its risk factors in the male population and most of these studies recruited patients who were attending health care clinics or other locations and not the general population. Accordingly, the aims of this study were as follows: (1) To assess the prevalence of osteopenia and osteoporosis among Saudi men aged 50 years and above and (2) To investigate the factors associated with osteoporosis and osteopenia.

MATERIALS AND METHODS

Study population and design: This was a cross-sectional study that recruited 1,022 Saudi men aged 50 years and above. The study was conducted at Al-Mashfa Hospital, Jeddah, Saudi Arabia, from September, 2014 to April, 2015. The sampling strategy involved the use of mobile phones due to their large penetration rates. For example, in 2014, mobile phones had a penetration rate of approximately 171%, with more than 50 million subscribers[12]. The recruitment strategy entailed collaboration with the three largest telecommunication companies in Saudi Arabia: Saudi Telecommunication Company, Mobily and Zain. An invitation to participate in the study was randomly sent via text message to mobile numbers owned by Saudi males, aged 50 years and older, who resided in Jeddah city. Appointments were made with individuals who responded to conduct interviews and obtain anthropometric measurements and biomarkers with participant consent.

Questionnaire: A structured questionnaire was designed and developed based on a review of the literature and previously published questionnaires. The questionnaire assessed the following information: (i) The sociodemographic characteristics of each participant, (ii) Lifestyle habits including smoking, physical activity, sun exposure and dietary calcium intake and (iii) The medical history, including the participant's history of fractures and osteoporosis. The sociodemographic variables that were collected included age, marital status, highest educational attainment and occupation. Information on sun exposure and smoking was obtained for each participant. Physical activity was defined as the average number of minutes spent per day performing each of the following two types of activity and the number of times per week each activity was performed: Walking and stretching or exercise/swimming at a fitness club. Calcium intake was assessed by asking each participant about the frequency with which he consumed certain food items, such as milk and other dairy products. Additionally, any history of falls in the

preceding 12 months and of fractures in the past 5 years was recorded. The questionnaire was pretested on 50 adult male patients in a pilot study. Two trained healthcare professionals interviewed participants. All participants signed informed consent forms and were informed that their participation was voluntary and that their responses were confidential. Ethical approval was obtained from the Biomedical Ethics Research Committee of King Abdulaziz University, Jeddah, Saudi Arabia.

Anthropometric measurements and biomarkers: All participants underwent femoral neck and lumbar spine BMD measurements using DEXA (Lunar, General Electric, Madison, WI, USA) to determine their osteoporotic statuses. The bone densitometry reports provided a T-score (the number of standard deviations (SDs) above or below the mean BMD for sex and race-matched young controls. The BMD results were used to classify patients into one of three categories: normal, osteopenic and osteoporotic. Individuals with BMD T-scores between -1 and -2.5 standard deviations below the young adult reference mean were considered osteopenic; those with BMD T-scores less than -2.5 standard deviations below the mean were classified as osteoporotic and those with BMD T-scores>-1 standard deviation were classified as normal. Anthropometric measurements, including height and weight, were obtained for all participants. Serum vitamin D [25(OH)D] levels and serum calcium levels were also measured. All interviews, examinations and tests were performed at AlMashfa Hospital, Jeddah, Saudi Arabia, from September, 2014 to April, 2015.

Data analysis: The main outcome (dependent) variable in this study was osteoporosis status. Osteoporosis status was defined according to the World Health Organization (WHO)[13] T-score criteria as follows: osteoporosis (T-score$\leq$-2.5), osteopenia (-2.5<T-score <-1.0) and normal (T-score$\geq$-1.0). Each individual was categorized into one of the osteoporosis status groups based on the lowest BMD T-score of the lumbar spine, right hip and left hip scores. The main independent variables that were included in the analysis were sociodemographic factors, lifestyle factors, anthropometric measurements and biomarkers.

The BMI was calculated according to the formula[2]:

$$MI = \frac{\text{Weight (kg)}}{\text{Height (m)}}$$

BMI was categorized using the WHO International Classifications for adults[2]. The principal cut-off points and their corresponding classifications were as follows: Underweight <18.5 kg m^{-2}; normal = 18.50- 24.99 kg m^{-2}; overweight = 25.00-29.99 kg m^{-2} and obese $\geq$30.00 kg m^{-2}. Vitamin D deficiency was categorized based on the Mayo Medical Laboratory reference ranges for total 25(OH)D serum levels[14]. Vitamin D levels were categorized as severe deficiency <10 ng mL^{-1}; mild to moderate deficiency = 10-24 ng mL^{-1}; optimal levels = 25-80 ng mL^{-1} and possible toxicity >80 ng mL^{-1}.

Categorical data were described using frequencies and percentages and continuous data were described using means and SDs. The associations between categorical predictors and osteoporosis status were evaluated using the chi-square test. The associations between continuous predictors and osteoporosis status were tested using t-tests and one-way analysis of variance (ANOVA). Tukey *post hoc* tests were conducted to determine significant intergroup mean differences when the one-way ANOVA was significant. A multinomial logistic regression model was used to identify the significant predictors of osteoporosis and osteopenia. All statistical analyses were performed using STATA version 13 (StataCorp, College Station, Texas, USA). The significance level was set at 0.05.

RESULTS

General characteristics of the study population: The study included 1,022 men aged 50 years and older. The sociodemographic and lifestyle characteristics of the study population were shown in Table 1. The Mean$\pm$SD age of the participants was 58.3$\pm$6.9 years, with a range of 50-87 years. Most of the men were married (99%). Most of the men were retired/unemployed (55%) or working in a government institute (29%). Regarding lifestyle factors, 27% were current smokers, 17% exercised 3 times per week for 30 min, 37% were exposed to the sun for more than 20 min per day and 5% had a calcium dietary intake of more than 1,000 mg a day.

The participants' family, medical and fracture histories were summarized in Table 2. Approximately 69% of the men had health problems, which were primarily diabetes (37%), high blood pressure (36%) and coronary artery disease (10%). Approximately 5% reported a fragility fracture after the age of 40 and a family history of such fractures. Regarding their osteoporosis history, only 6% reported a previous bone

Table 1: Sociodemographic characteristics and lifestyle factors of the study population

Factors	N	Percentage
Sociodemographic		
Age (years) (Mean±SD)	58.3±6.9	
50-54	382	37.4
55-59	243	23.8
60-64	210	20.6
65-70	97	9.5
70+	90	8.8
Marital status		
Married	1008	98.6
Non-married	14	1.4
Highest education level		
Elementary or below	123	12.0
Secondary or diploma	318	31.1
University	431	42.2
Postgraduate	150	14.7
Occupation		
Government	296	29.0
Private	62	6.1
Self-employed	106	10.4
Retired/Unemployed	558	54.6
Lifestyle		
Smoking status		
Never	428	41.9
Previous	321	31.4
Current	273	26.7
Physical activity		
No exercise	682	66.7
Exercise<30 min 3 times/week	170	16.6
Exercise ≥30 min 3 times/week	170	16.6
Sun Exposure		
<20 min day^{-1}	643	63.0
≥20 min day^{-1}	379	37.0
Dietary calcium intake		
<1,000 mg day^{-1}	954	94.7
≥1,000 mg day^{-1}	53	5.3

SD: Standard deviation

density test. Additionally, 10% reported taking medication to treat or prevent osteoporosis.

The anthropometric measurements, biomarkers and BMD t-scores were shown in Table 3. The Mean±SD height and weight of the participants were 167.8±9.0 cm and 88.8±18.6 kg, respectively. Approximately 36% of the men were overweight, 52% were obese and 12% were underweight/normal. The total mean (±SD) serum vitamin D and calcium levels were 22.2±10.2 ng mL^{-1} and 9.5±1.02 mg dL^{-1}, respectively. Approximately 3% of the men had a severe vitamin D deficiency, 65% had a mild to moderate deficiency and 32% had optimal levels.

Prevalence and predictors of osteoporosis: Based on the lowest value of the lumbar spine, left hip and right hip BMD T-scores, approximately 9% of the men had osteoporosis, 41% had osteopenia and 50% were normal. The associations between osteoporosis status and the sociodemographic, lifestyle and anthropometric variables of the participants were summarized in Table 4. Men with higher educational attainment had a lower prevalence of osteoporosis (p-value = 0.013). Additionally, men with higher BMIs had a lower prevalence of osteoporosis (p<0.001). The prevalence of osteoporosis was 6, 11 and 19% among obese, overweight and normal men, respectively.

Table 2: Medical, fracture and osteoporosis histories of the participants and their families

History	N	Percentage
Medical and fracture		
Health problems		
No	322	31.5
Yes	700	68.5
Most common health problems		
Diabetes	382	37.4
High blood pressure	366	35.8
Coronary artery disease	104	10.2
Fragility fracture after age 40		
No	913	95.0
Yes	48	5.0
Family history of fragility fracture after age 40		
No	870	94.8
Yes	48	5.2
Osteoporosis		
Previous bone density test		
No	952	93.7
Yes	64	6.3
Previous diagnosis with osteopenia/osteoporosis		
No	981	96.0
Yes	41	4.0
Osteoporosis prevention/treatment medication		
No	906	90.1
Yes	100	9.9
Osteoporosis medication discontinued		
No	872	91.5
Yes	81	8.5
Family history of osteoporosis		
No	636	72.0
Yes	247	28.0

Based on the multinomial model of osteopenia compared to normal, two variables, namely, education and BMI were significant as shown in Table 5. Compared to men with an elementary degree or below, men with a secondary degree or diploma and men with a university or postgraduate degree had a 50% (relative risk ratio (RRR) = 0.05, p<0.01) and 46% (RRR = 0.54, p<0.05) lower relative risk, respectively, of having osteopenia. Compared to men of normal weight, obese men had a 56% lower relative risk of osteopenia (RRR = 0.44, p-value<0.001). Furthermore, for the outcome of osteoporosis compared to normal, variables including age, BMI, smoking and family history of fragility fractures were significant

Table 3: Anthropometric measurements, biomarkers and T-scores

Variables	N	Percentage
Height (Mean±SD, cm)	167.8±9.0	
Weight (Mean±SD, kg)	88.8±18.6	
BMI (Mean±SD, kg m^{-2})	32.4±19.3	
BMI classification		
Underweight/normal	124	12.1
Overweight	366	35.8
Obese	533	52.1
Serum 25(OH) D (Mean±SD, ng mL^{-1})	22.2±10.2	
Vitamin D deficiency		
Severe deficiency	33	3.2
Mild to moderate deficiency	660	64.6
Optimal	329	32.2
Serum calcium (Mean±SD, mg dL^{-1})	9.5±1.02	
Lumbar spine T-score (Mean±SD)	-0.5±1.4	
Normal	607	59.4
Osteopenia	339	33.2
Osteoporosis	76	7.4
Right hip T-score (Mean±SD)	-0.4±1.3	
Normal	706	69.1
Osteopenia	285	27.9
Osteoporosis	31	3.0
Left hip t-score (Mean±SD)	-0.4±1.2	
Normal	699	68.4
Osteopenia	292	28.6
Osteoporosis	31	3.0
Osteoporosis status		
Normal	511	50.0
Osteopenia	416	40.7
Osteoporosis	95	9.3

SD: Standard deviation, BMI: Body mass index, 25(OH)D, 25-hydroxyvitamin D: T-score, the number of standard deviations above or below the mean bone mineral density of the reference

(Table 5). The relative risk of osteoporosis was 3 times higher for men who reported a family history of fragility fractures compared to men who did not (RRR = 2.88, p-value<0.05). Additionally, smokers had a 2.37 times higher relative risk of osteoporosis compared to non-smokers (RRR = 2.37, p-value<0.05). The relative risk of having osteoporosis compared to normal increased 1.05 times for each 1 year increase in age. Compared to men of normal weight, obese men and overweight men had a 54% (RRR = 0.46, p-value<0.05) and 82% (RRR = 0.18, p-value<0.001) lower relative risk, respectively, of osteoporosis.

DISCUSSION

Osteoporosis is a major health problem worldwide. However, most studies, including those in Saudi Arabia, have focused on investigating osteoporosis in postmenopausal women. This cross-sectional study aimed to determine the prevalence of osteoporosis and osteopenia and their related risk factors in the Saudi male population. The main findings of the study were that the prevalence of osteopenia was high (40.7%) and that the prevalence of osteoporosis was 9.3%. The main risk factors associated with low bone mass were age, education, BMI, smoking and a family history of fragility fractures.

The prevalence of osteopenia was high in the study population, with 40.7% of men affected; the highest prevalence occurred among men aged 50-69 years. The osteoporosis prevalence was 9.3%, with the highest prevalence among men aged 70 years and older. Most of the studies in Saudi Arabia that examined men over 50 years of age have reported a higher prevalence of osteoporosis than the percentages reported in both our study and other countries worldwide. Sadat-Ali and AlElq[9] reported a prevalence of osteoporosis and osteopenia of 37 and 34%, respectively, among Saudi males in outpatient clinics. El-Desouki and Sulimani[10] reported a prevalence of 24% among men recruited from local social clubs and meetings. The highest prevalence of osteoporosis was reported by Ardawi *et al.*[15], in approximately 38% of either the spines or femurs of men selected from primary healthcare centres. The selection of samples in these studies might explain the higher observed prevalence of osteoporosis compared with our results.

Studies from adjacent countries have reported similar findings to those of our study. The prevalence of osteoporosis among Lebanese men aged 50-79 years, who were recruited through Lebanese health organizations and advertisements, was 9%[16]. The Iranian Multi center Osteoporosis Study (IMOS) reported an osteoporosis prevalence of10.2% among Iranian men[17]. Current findings were also similar to those of western countries; the prevalence of osteoporosis in men was reportedly 17.7% in Denmark, 6% in the United Kingdom (UK) and 10% in Australia[18-20].

Several modifiable and thus preventable risk factors were associated with both osteoporosis and osteopenia in this study. Age, BMI, smoking and family history of fragility fractures were important determinants of osteoporosis, whereas education and smoking contributed to the risk of osteopenia. Our study found that obesity decreased the risk of osteoporosis and osteopenia, which is consistent with other studies[21-23]. In Saudi Arabia, Ardawi[15] reported that body weight was a significant predictor of BMD at all skeletal sites examined and was more important than height in a multiple regression analysis. Saudis who were 50 years old or older and in the lowest body weight quartile exhibited a higher

Table 4: Bivariate analysis of osteoporosis status and other study variables

	Normal (N = 511)		Osteopenia (N = 417)		Osteoporosis (N = 94)		
Variables	N	Percentage	N	Percentage	N	Percentage	p-value*
Age (years) (Mean±SD)	57.7	6.60	58.2	6.7	61.2	8.40	<0.001
Highest education level							
Elementary or below	47.0	38.20	57.0	46.3	19.0	15.50	0.013
Secondary or diploma	161.0	50.60	125.0	39.3	32.0	10.10	
University or postgraduate	303.0	52.20	235.0	40.5	43.0	7.40	
Smoking status							
Non-smoker	382.0	51.00	307.0	41.0	60.0	8.00	0.087
Smoker	129.0	47.25	110.0	40.3	34.0	12.50	
Physical activity							
No exercise	327.0	48.00	282.0	41.4	73.0	10.70	0.136
Exercise <30 min 3x/week	91.0	53.50	68.0	40.0	11.0	6.50	
Exercise >30 min 3x/week	93.0	54.70	67.0	39.4	10.0	5.90	
Sun exposure							
<20 min/day	320.0	50.00	258.0	40.1	65.0	10.10	0.368
>20 min/day	191.0	50.40	159.0	42.0	29.0	7.70	
BMI classification							
Underweight/normal	42.0	33.90	58.0	46.7	24.0	19.40	<0.001
Overweight	156.0	42.60	171.0	46.7	39.0	10.70	
Obese	313.0	58.80	188.0	35.3	31.0	5.80	
Vitamin D deficiency							
Deficient	346.0	49.30	285.0	41.1	62.0	9.00	0.903
Optimal	165.0	50.20	132.0	40.1	32.0	9.70	
Calcium levels							
1st tertile	164.0	48.10	141.0	41.4	36.0	10.60	0.558
2nd tertile	177.0	51.30	135.0	39.1	33.0	9.60	
3rd tertile	170.0	50.90	140.0	41.8	24.0	7.20	
Family history of fragility fractures							
No	473.0	51.80	366.0	41.1	74.0	8.10	0.189
Yes	20.0	41.70	21.0	43.8	7.0	14.60	
Family history of osteoporosis							
No	318.0	50.00	261.0	41.0	57.0	9.00	0.655
Yes	115.0	46.60	108.0	43.7	24.0	9.20	
Diabetes							
No	310.0	48.40	269.0	42.0	61.0	9.50	0.432
Yes	201.0	52.60	148.0	38.7	33.0	8.60	

Min: Minutes, BMI: Body mass index, *Chi-square test was used, †One-way ANOVA and Tukey *post hoc* test were used for multiple comparisons, Osteoporosis>Normal and Osteoporosis>Osteopenia

prevalence of osteoporosis (25.6% in females and 15.5% in males) than Saudis in the highest body weight quartile (0.0% in females and 0.8% in males).

In current study, smoking was prevalent and found to double the risk of osteoporosis. Smoking is almost universally recognized as a risk factor of low BMD and increased fracture risk[24,25]. Additionally, a family history of fragility fractures was found to increase the risk of osteoporosis; the strong genetic component of osteoporosis might partially explain this increased risk[26]. However, the mechanisms behind the relationship remain unclear. Our study also found that education level was a protective factor against both osteoporosis and osteopenia. This protective effect might be due to an elevated level of awareness of the risk factors for and prevention of osteopenia and osteoporosis among individuals with more education.

Data from prior studies indicate that inactivity, poor intake of dietary calcium and lack of sun exposure contribute to the pathogenesis of osteoporosis in men[22]. Our study did not find that these factors were associated with osteoporosis; however, these factors were highly prevalent in the population. Sixty-three percent of the population was exposed to the sun for less than 20 min per day. This finding may be due to the avoidance of sun exposure by Saudis[27,28]. Similarly, 67% of the population did not exercise and calcium intake was poor, with almost 95% of the population consuming less than 1,000 mg/day. Although these factors were not associated with osteoporosis in our study, they are common risk factors

Table 5: Multinomial logistic regression of osteoporosis status and other study variables*

	Osteopenia (N = 417)		Osteoporosis (N = 94)	
Variable	RRR	95% CI	RRR	95% CI
Age (years)	1.01	0.99, 1.03	1.05‡	1.01, 1.09
Highest education level				
Elementary or below	1.00	1.00		
Secondary or diploma	0.50†	0.29, 0.83	0.47	0.19, 1.09
University or postgraduate	0.54‡	0.33, 0.88	0.47	0.21, 1.04
BMI classification				
Underweight/normal	1.00	1.00		
Overweight	0.79	0.48, 1.30	0.46‡	0.22, 0.95
Obese	0.44‡‡	0.27, 0.71	0.18‡‡	0.09, 0.39
Smoking status				
Non-smoker	1.00	1.00		
Smoker	1.11	0.79, 1.56	2.37‡	1.37, 4.11
Physical activity				
No exercise	1.00	1.00		
Exercise <30 min 3x/week	0.85	0.57, 1.28	0.52	0.22, 1.22
Exercise ≥30 min 3x/week	0.8	0.54, 1.19	0.59	0.26, 1.34
Sun exposure				
<20 min day^{-1}	1.00	1.00		
>20 min day^{-1}	0.94	0.69, 1.28	0.68	0.38, 1.20
Vitamin D deficiency				
Deficient	1.00	1.00		
Optimal	0.87	0.63, 1.21	0.74	0.40, 1.36
Calcium levels				
1st trial	1.00	1.00		
2nd trial	0.88	0.61, 1.27	0.99	0.53, 1.86
3rd trial	1.04	0.72, 1.50	0.74	0.37, 1.45
Family history of fragility fracture				
No	1.00	1.00		
Yes	1.43	0.70, 2.91	2.88‡	1.06, 7.78
Family history of osteoporosis				
No	1.00	1.00		
Yes	1.31	0.94, 1.83	1.66	0.92, 3.01

BMI: Body mass index, RRR: Relative risk ratio, *Outcome: Osteoporosis status reference category = normal, †p-value<0.01, ‡p-value<0.05, ‡‡p-value<0.001

for other chronic diseases and should be addressed early to prevent the occurrence of such diseases in older individuals.

This study has several limitations. First, the cross-sectional design makes it difficult to determine temporal relationships between risk factors and osteoporosis status. Second, the self-reported nature of the questionnaire might have introduced recall and response bias. However, osteoporosis status was objectively assessed and measured, thus limiting bias in the outcomes. Third, the questionnaire was not validated; however, it was piloted and reviewed by experts in the field. Fourth, although the penetration rates of mobile phones are high, the use of phones to recruit participants might have under represented people who do not own mobile phones, leading to results that may not be generalizable to all Saudi men living in Saudi Arabia.

CONCLUSION

The study findings revealed that the prevalence of osteopenia was significantly high compared with the prevalence of osteoporosis in Saudi men aged 50 years and above. Furthermore, both higher BMI and higher education were protective against osteoporosis, while smoking and family history of hip-related fractures were significant contributors to the risk of osteoporosis.

The data gathered from this large sample of Saudi male patients in this study will contribute to the development of new strategies and policies to prevent and treat osteoporosis, particularly among the high-risk elderly population. Furthermore, the results of our study highlight the importance of increasing the awareness of osteopenia and osteoporosis among physicians, nurses, nutritionists, dentists and other healthcare workers. Assuming that the status of osteoporosis

and its related risk factors among Saudi men does not change, it is possible that a large proportion of middle-aged men are likely to develop osteoporosis-related fractures in the future. This development would, in turn, place a huge burden on the health resources of the country.

SIGNIFICANCE STATEMENT

This study reported that the prevalence of osteopenia and osteoporosis among Saudi males is high but lower than other published research in the country. As for risk factors, both higher BMI and higher education were protective against osteoporosis, while smoking and family history of hip-related fractures were significant contributors to the risk of osteoporosis. These findings are useful as data gathered from this large sample of Saudi males should contribute to the development of strategies and policies to prevent and treat osteoporosis, particularly among the high-risk elderly population.

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