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Obesity and Osteoporosis Among Students in Umm Al-Qura University Makkah, KSA

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ABSTRACT

Background: Nutrition is one of the most important factors influencing human health. Also, nutrition plays a role in the etiology of osteoporosis disease. This disease is a serious metabolic bone disorder that often results in hip fracture and is usually asymptomatic in its initial stages. **Objective:** Assess the prevalence of obesity and osteoporosis among university students. **Methods:** A cross sectional study was carried out during the period from 1/1/2010 to 30/1/2013 among a random sample of 218 male and 257 female university students participate from Umm Al Qura university of Makkah age ranged from 19 to 24 years old. A direct interview was run all students to collect a specially designed bone health related questionnaire, bone mineral density (BMD) sos instrument and body composition have also been measured by using scale body state device. **Results:** Osteoporosis was present in 2.8% and 7% for male and female respectively, while osteopenia was current in 42.2% and 32.3% of male and female resp. Moreover there was a highly increased positive significant relationship at level (1%) between osteoporosis and each of body fat %, fat weight, and BMI. **Conclusion:** Osteoporosis more common in female students, while osteopenia is increased in male students. The prevalence of osteoporosis among university students was positively and significantly associated ($p<0.001$) with increased body fat. The study results suggested that inevitable decrease in body fatness and weight with less consumption of carbonated beverages, taking into consideration variety and balanced diets and increasing nutrition education programs.

Keywords: *Osteoporosis, Osteopenia, Bone mineral density, Body fat, University students and Umm Al-Qura University*

Introduction

Osteoporosis is the most common metabolic disease in western society [1], characterized by low bone mass, where Diane, reported that a normal bone mineral density BMD is in the range of ±1SD of the mean value of peak bone mass in young adult 30 years old women [2]. Osteoporosis occurs when BMD is lower than -2.5SD which often leading to a decrease in quality of life [3]. Lower bone mineral density was found in greater proportion among older females. Majority needed intervention inclusive of awareness through health education and medication [4]. Several studies stated that one in three women and one in 12 men over the age of 50 years being affected in the UK and with health care resources being estimated at 5 million sterling pounds per day, osteoporosis poses a significant public health problem [3]. Furthermore, it is a serious metabolic bone disorder that often results in hip fracture and is usually asymptomatic in its initial stages [5].

An international trend indicates that hip fractures can rise from1.7 million in 1990 to 6.3 million by 2050 and that figure is relevant to Saudi Arabia with recent socio-economic progress and change in living conditions resulted in increased life expectancy[6]. Studies in Saudi Arabia showed that BMD of the normal Saudi population is lower than the normal Caucasian US population [7]. At Saudi Arabia level, a study in King Khalid University Hospital, Riyadh, in 437 female adult

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patients, aged 20-87 demonstrated that most of the sample suffers from osteoporosis with lower BMD estimation of lumbar spine for 31%, followed by femoral neck (14%), forearm (11%), and heel (6%) [8] which involved in bone fracture.

Adolescence, characterized by changes in height, weight and body composition, is also a crucial period for bone mineral accrual [9]. Approximately 40% of peak bone mass, a major determinant of osteoporosis, is accumulated during adolescence. This in girls will protect against post-menopausal osteoporosis [10]. In fact, peak bone mass, is influenced by genetic, nutritional, lifestyle and hormonal factors [11]. However, the increasing proportion of underweight young women may lead to an increase in those with low bone mass [12].

Alarming figures from national surveys indicated that poor dietary habits for many teenagers and young adults worldwide showed that they would not meet the recommended intake of calcium, additionally 13% of 11–18 year olds have a poor vitamin D status. The dietary intake is characterized by higher consumption of processed energy dense food and soft carbonated drinks where both will affect bone health and BMD level. Regarding adverted life-style including physical activity and smoking; 64% of girls aged 15 years participate in less than 30 minutes of physical activity five times per week and 33% of 15–18 year olds teenagers' smoke [13,14]. This in the long run might end on obesity and increased fat mass.

In several observational studies, intake of carbonated beverages was associated with reduced bone mass, decreased calcium level in the blood, and increased fracture risk [15]. Soft drink consumption has exploded over the past three decades [16], demonstrating a per capita availability increase from 22 gallons to 52 gallons [17, 18]. In the USA, carbonated soft drinks and milk are the two most popular non-alcoholic beverages, accounting for 39.1% of total beverage consumption [19]. A recent study in Saudi Arabia in 5033 boys and 4400 girls aged 10 to 19 years on dietary intake and obesity showed that Sugar-sweetened carbonated beverage consumption varied from 5.93 to 9.04 servings a week by age, and was significantly higher than consumption of non-caloric sweetened "Diet" carbonated beverage , which varied between 0.92 and 1.52 servings per week [20]. Thus, obesity combined with poor dietary habits can increase osteoporosis.

Therefore, our investigation aimed to assess osteoporosis among male and female university students which grantee an important research area on poor dietary pattern and with higher body obesity.

Materials and Methods

Subjects

A cross-sectional study was carried out in the period from 1/1/2010 to 30/1/2013 among19-24 years old university students. The study included 218 male and 257 randomly selected male and female students from clinical nutrition, nurse, pharmacy, laboratory medicine, departments and faculty of medicine enrolled at Umm Al Qura University in Makkah Governorate.

Methods

Consent has been signed by the participant before study bone health related questionnaire. Ethical committee approval for the study has been proofed in advancement of the direct project. Data were collected by interview using Anthropometric data for height and weight were completed on the same day on which BMD was measured. Height was recorded without shoes; using a wall stadiometer to the nearest 1 mm. Subjects were weighed using a clinical balance wearing light clothing and without shoes to the nearest 0.1 kg. Body Mass Index (BMI) was calculated as weight (in kg)/height (in m^2)[21]. On daily basis, calibration of the scale and stadiometer were conducted.

BMD from students' wrist was measured by bone densitometry scan using BeamMed made by (sunlight) 7000/8000 series, Type/CSB serial No.5718 [22]. The World Health Organization (WHO) definition of osteoporosis, osteopenia and normal bone density is used throughout this study [10]. Diane (2001) reported that a normal BMD is not more than -1 SD below the mean value of peak bone mass in young adult women. Osteopenia is indicated by a BMD of between -1 and -2.5 SD below the mean value. The BMD of a patient with osteoporosis is more than -2.5 SD below the mean value of peak bone mass, and patients with severe osteoporosis exhibit fractures and a BMD of more than -2.5 SD below the mean value. Body composition was measured using Bodystat®1500. The standard and detailed methods for measurements of BMD and body composition were showed somewhere else [23].

Statistical package spreadsheet software (SPSS) version 16. was used for statistical analysis [24]. Mean±SD (range) and analysis of variance (ANOVA) test were used as appropriate. Anthropometric measurements, dietary and BMD parameters were compared between the groups. The results were reported as mean (95%). $P<0.05$ was considered significant.

Bone speed of sound (SOS)

Bodystat®1500

Results

Table 1, shows that frequency distribution of studied samples according to bone mass density which reveals that about 2.8% and 7% for male and female resp. were suffering from osteoporosis while, osteopenia was current in 42.2% and 32.3% of male and female respectively.

Table 2, shows the frequency distribution of total samples according to grades of BMI. The majority of male and female students have overweight problem (BMI equal 18-24.9 Kg/m^2) with (39% and 55%)of male and female students respectively. As for male samples, about 30.3%, 13.8% and 5.5% were obese, clinically obese and morbidly obese respectively compared with 18.7%, 3.1% and 3.1% for female students. Concerning total studied samples, about 24.0%, 8.0% and 4.2% were obese, clinically obese and morbidly obese respectively while less than 15%of the total sample has a normal weight.

Table 3, shows the association between BMI and BMD for the studied samples. It is worth to mentioning that, all osteoporotic male patients have over weight, meanwhile about 33.3% vs 12.0% of osteoporotic female patients and osteopenia cases were obese, while 16.7% vs 20.5% respectively were overweight.

Regarding osteoporotic female patients, about 5.6% have starvation compared with 27.8% have morbidly obese, while in normal group, results revealed that only 4.5% vs 14.1% were obese and were overweight resp.

Table 4, shows that the mean of fat mass(%)for osteoporosis group was significantly less (P<0.01) than osteopenia and normal students (20.5±6.8, 23.6±9.7and 21.9±5.4% resp.), the same trend was observed for fat weight mass (kg) (P<0.001). Also, significant difference (P<0.05) was informed for dry lean mass (%), where it was 23.4±3.7 for osteoporotic, 68.4±14.3 for osteopenic and then 36.9±27.2 for normal samples, the same trend was observed also for lean mass (kg) (P<0.001).

Mean values with ±SD for fat mass%, fat weight mass (kg), dry lean mass%, and lean mass weight (kg) for the female samples are shown in table 5. The mean of fat mass% for osteoporosis group was significantly

Table 1: Frequency distribution of studied samples according to BMD.

Groups / BMD	Male		Female		Total		χ^2
	No.	%	No.	%	No.	%	P value
Normal	120	55.0	156	60.7	276	58.1	8.010[a]
Osteopenia	92	42.2	83	32.3	175	36.8	
Osteoporosis	6	2.8	18	7.0	24	5.1	0.018
Total	218	45.9	257	54.1	475	100	

Table 2: Frequency distribution of total samples according to grades of BMI.

Groups / BMI (Kg/m^2)	Male		Female		Total		χ^2
	No.	%	No.	%	No.	%	P value
Underweight	0	0	2	0.8	2	0.4	44.055[a]
Normal	26	11.9	50	19.5	76	16.0	0.00
Overweight	84	38.5	141	54.9	225	47.4	
Obesity	66	30.3	48	18.7	114	24.0	
Clinically Obese	30	13.8	8	3.1	38	8.0	
Morbidly Obese	12	5.5	8	3.1	20	4.2	
Total	218	100.0	257	100.0	475	100.0	

Table 3: Comparison between male and female samples according to grades of BMI and BMD.

BMD	Male						Female						χ^2
	Normal		Osteopenia		Osteoporosis		Normal		Osteopenia		Osteoporosis		P value
BMI (Kg/m^2)	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	57.87
Starvation	0	0	0	0	0	0	1	0.6	0	0	1	5.6	
Normal	14	11.7	12	13.0	0	0	35	22.4	14	16.9	1	5.6	0.00
Overweight	54	45.0	24	26.1	6	100	92	59.0	43	51.8	6	33.3	
Obesity	32	26.7	34	37.0	0	0	24	15.4	21	25.3	3	16.7	
Clinically Obese	14	11.7	16	17.4	0	0	4	2.6	2	2.4	2	11.1	
Morbidly Obese	6	5.0	6	6.5	0	0	0	0	3	3.6	5	27.8	

Table 4: Mean±SD values of fat mass %, fat mass weight (kg), dry lean mass %, and lean mass weight (kg) classified by BMD categories for the male samples

Groups / Parameters	RR	Normal	Osteopenia	Osteoporosis	ANOVA	
		Mean±SD	*Mean±SD*	*Mean±SD*	*F*	*Sig.*
Fat mass %	14-20	21.9±5.4	23.6±9.7	20.5±6.8	6.429	0.002
Fat Weight mass *kg*	13-19	16.8±8.2	20.5±15.1	10.7±2.5	9.905	0.000
Dry lean mass %	75-81	36.9±27.2	68.4±14.3	23.4±3.7	3.737	0.025
Lean Weight mass *kg*	29%BW	51.2±6.2	53.9±8.3	44.3±4.9	6.829	0.001

kg.: kilogram *RR: Recommended Range*

Table 5: Mean±SD values of fat mass %, fat mass weight (kg), dry lean mass %, and lean mass weight (kg) classified by BMD categories for the female samples

Groups / Parameters	RR	Normal	Osteopenia	Osteoporosis	ANOVA	
		Mean±SD	*Mean±SD*	*Mean±SD*	*F*	*Sig.*
Fat mass %	14-20	30.8±6.1	32.1±7.7	37.8±9.83	8.202	0.000
Fat Weight mass *kg*	13-19	17.2±6.1	20.1±9.1	28.9±16.5	17.4	0.000
Dry lean mass %	75-81	11.5±5.1	12.6±6.1	12.9±3.9	1.387	0.252
Lean Weight mass *kg*	29%BW	35.7±8.3	37.8±8.7	41.5±9.3	4.523	0.012

kg.: kilogram *RR: Recommended Range*

higher (P<0.001) than osteopenia and normal students (37.8±9.83, 32.1±7.7 and 30.8±6.1 % resp.). This is hold true for fat weight mass (kg) in osteoporotic students where a significant difference between means (P<0.001) was observed in comparison to osteopenia and normal students (28.9±16.5, 20.1±9.1 and 17.2±6.1kg resp.). However, no significant difference was reported for dry lean mass (%), where it was 12.9±3.9 for osteoporotic, 12.6±6.1 for osteopenic and then 11.5±5.1 for normal students. Concerning lean weight mass (kg), the mean was significantly higher (P<0.01) for osteoporotic than in osteopenic and normal students (41.5±9.3, 37.8±8.7 and 35.7±8.3 (kg) resp.). In general, there are trends which went up as BMD score went down.

Discussion

Peak bone mass is a key determinant of skeletal health throughout life [25]. The attainment of peak bone mass is influenced by genetic and environmental factors. However, nutritional factors have considerable effects [26, 27]. Our results revealed that about 7% of female students had osteoporosis (T-score of -2.5 or lower), while osteopenia (T score between-1 and-2.4) demonstrated in 32.3% of them. Previously, results of pharmacist students in Iowa City, USA, showed that the mean (±SD) T- and Z-scores for these participants were 0.03±1.30 and 0.52±1.13, respectively. Out of the Iowa study, the total number of the women whom screened and had an increased risk of fracture, based on a T-score of -1 or less, was 62 (19.4%), whereas approximately two-thirds of all women had better-than-average BMD[28].

Most of osteoporotic subjects in the current study preferred coffee, compared with osteopenic and normal ones. These results are in accordance with El Maghraoui who noticed that, using multiple regression analysis, only age, BMI, and high coffee consumption were independently associated to the osteoporosis status [29]. This findings was reported as well in a recent study, where in men with coffee consumption of 4 cups or more per day had 4% lower BMD at the proximal femur (p = 0.04) compared with low or non-consumers of coffee, yet no significant difference had noticed in women [30].

The National Osteoporosis Foundation suggested that the consumption of three or more cups of coffee per day may affect bone density with high caffeine consumption is linked to an increased lifetime risk of low bone density. The foundation had elucidated that caffeine decreases slightly the ability of the body to absorb calcium, hence, it advises to keeping caffeine to moderate [31].

Sugar sweetened soft drinks became a major source of added sugar in the American diet [32, 33] and have been linked to adverse nutritional and health consequences such as obesity[32,34,35]. The same results were observed for carbonated beverages in our study. Evidence supports an association between soft drink consumption and decreased bone mineral density (BMD) [36-38]. This could be explained on the light of that the higher content of phosphorous in Soda drinks was associated with decreasing level of blood calcium and increasing urinary calcium excretion, which may lead to osteoporosis later in life [39].

To define obesity, BMI is usually used, where obese people are those with BMI >30. BMI is a number calculated from a person's weight and height [21, 40]. A direct measure is the body composition analysis by electric impedance technique, where lean and fat masses are determined with 13-19kg of total body fat is from fat mass to be considered as normal level [41].

It has been reported in the past that obesity significantly decreases the risk for osteoporosis but did not decrease the risk for osteopenia [42]. Overweight and obese adolescents in the final stages of sexual maturity have been found to had higher BMD in relation to their normal-weight counterparts; however, cohort studies will be necessary to evaluate the influence of such characteristic on bone resistance in adulthood and, consequently, on the incidence of osteopenia and osteoporosis at older ages [43]. Additionally, for a given body size measured either by body composition or height women with greater fat mass have greater BMD [44].

Several studies reported that BMD is related positively to

weight and BMI, although, no clear evidence either was that to lean or fat masses [45,46]. This positive association might be a result of increased mechanical loading on the skeleton due to affect of higher body weight. Furthermore, the secretion of endocrine and paracrine factors that strongly influence neighboring cell function and distant activities by fat mass and fat cells is long time well established fact. Thus, the role of adipocytes as active tissues associated and in particular fat mass with the secretion of bone-active hormones from the pancreatic β-cell (i.e. insulin, amylin, resistin and preptin); and secretion of bone-active factors (i.e. estrogen, leptin, and adiponectin) might influences and regulates BMD [45].

However, a recent study has documented a high prevalence of obesity in postmenopausal women with fragility fracture, but not with lower BMD. Nearly one in four postmenopausal women with fractures is obese. When compared to non-obese women, obese women with a prevalent fracture were more likely to be current cortisone users, to report early menopause, to report fair or poor general health, to use arms to assist standing from a sitting position, and to report more than two falls in the past year [46].

The final argument can be clarified on the light of that fat mass, as mentioned above, can generate estradiol from testosterone in post menopausal obese women. Out of these products namely, the cytochrome P450 enzyme, aromatase, could be expressed, which inhibit the pathway of osteoclastogenesis in the bone marrow, hence, less osteoclast generated, leading to slower rates of bone loss [47-49] nevertheless, in obese individuals, adiposity, insulin resistance and effects of thiazolidine dione treatment enhance skeletal fragility of bones. Moreover, both exogenous glucocorticoid use and endogenous over production of cortisol for a prolonged period are associated with low BMD and a significantly greater risk of fracture, as stated in several studies [50, 51].

A similar finding was reported in the current research, where BMI and fat% for osteoporotic students were significantly higher than osteopenic students. A recent supportive evidence came from study to agree with our results and suggest that both lean mass and fat mass are important determinants of BMD [21, 40].

Furthermore, the key finding of a Chinese study in the relation between obesity and BMD found that, when confounding factor such as the mechanical loading effects of body weight on bone mass is controlled for, fat mass (or PFM) is inversely correlated with bone mass [52]. In supportive studies increased bone-marrow adiposity in postmenopausal women with osteoporosis was showed, and a negative association between bone-marrow fat and rate of bone formation was confirmed [53-55].

An opposite view was presented in a study about contributions of lean and fat masses with BMD, both BMD and body compositions were measured, the study found that in 921 mixed races women (African-American, Asian, Latino and Caucasian), aged 20–25 years, lean mass rather than fat mass was more positively related to BMD [46].

A recent study on CONGENIC mice, which have suppressed skeletal and hepatic insulin-like growth factor 1, found that a noticeable reduced bone mass, explicitly on the trabecular bone had taken place [56]. Furthermore, the fat mass on bone marrow and the liver on these mice were elevated, yet, they have normal total body weight. The research group found interestingly that a marked reduction in bone formation as well as the number of osteoblast progenitors had occurred. It could be explained by inhibition of osteoblast lineage differentiation and shifting towards adipocytic differentiation, suggesting that from this model, fat redistribution, rather than generalized adiposity, might be a better indicator of impaired osteoblastogenesis.

Number of potential strengths and weaknesses could affect the present results interpretation. The participants were randomly drawn from the university population which should ensure its validity. The electric impedances measurements of fat mass, lean mass and bone mass, although not direct, are accurate and reliable, which ensure the internal validity of the study. However, the average number of students was relatively small, which might affect generalisability of these findings. The sample lifestyles, nutritional and physical activity may differ from other populations. The study design was cross-sectional, and it is not possible to make any cause-and-effect inference on the relationship between lean mass, fat mass and BMD.

Discussion

Osteoporosis and osteopenia were prevalent among male and female students. There was a positive significant relationship at level (0.1%) between prevalence of osteoporosis and body fat mass. Thus, our investigation suggested that measurement of BMD should include younger adult addition to the standard age of 50 or above and A bone density scan must be measured annually to reduce the risk of bone fractures Also, Maintaining healthy body weight and BMI in the normal range meanwhile providing healthy snacks and meals options and to prohibit selling carbonated beverages for students in the universities in Saudi Arabia was encouraged to avoid excessive caffeine, soft drinks, and processed food intake.

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References

1. Ilich J, Badenhop N, Matkovic V: **Primary prevention of**

osteoporosis: pediatric approach to disease of the elderly. *Women's Health* 1996, 6(4):194–203.

2. Diane B: **Bioidentical Hormones in the Treatment of Osteoporosis**. *Int J Pharm Compd* 2001, 5:341.
3. Bennell K, Khan K, McKay H: **The role of physiotherapy in the prevention and treatment of osteoporosis**. *Man Ther* 2000, 5(4):198–213.
4. Baig L, Mansuri FA, Karim SA: **Association of menopause with osteopenia and osteoporosis: results from population based study done in Karachi**. *J Coll Physicians Surg Pak* 2009, 19(4): 240-244.
5. Hazavehei SM, Taghdisi MH, Saidi M: **Application of the Health Belief Model for osteoporosis prevention among middle school girl students, Garmsar, Iran**. *Educ Health (Abingdon)* 2007, 20(1):23.
6. Cooper C, Campion G, Melton LJ: **Hip fracture in elderly: a worldwide projection**. *Osteoporos Int* 1992, 2:285-289.
7. Ghannam NN, Hammami MM, Bakheet SM, Khan BA: **Bone mineral density of the spine and femur in healthy Saudi females: Relation to Vitamin D status, pregnancy and lactation**. *Calcif Tissue Int* 1999, 65:23-28.
8. El-Desouki MI, Sherafzal MS, Othman SA: **Comparison of bone mineral density with dual energy x-ray absorptiometry, quantitative ultrasound and single energy x-ray absorptiometry**. *Saudi Med J*. 2005, 26(9):1346-1350.
9. Kun Z, Greenfield H, Xueqin D, Fraser DR: **Improvement of bone health in childhood and adolescence**. *Nutr Res Rev* 2000, 14:119–52.
10. Matkovic V, Jelic T, Wardlaw GM, Ilich JZ, Goel PK, Wright JK, et al.: **Timing of peak bone mass in Caucasian females and its implication for the prevention of osteoporosis.Inference from a cross-sectional model**. *J Clin Invest* 1994, 93:799–808.
11. Marwaha RK, Puri S, Tandon N, Dhir S, Agarwal N, Bhadra K, Saini N: **Effects of sports training & nutrition on bone mineral density in young Indian healthy females**. *Indian J Med Res* 2011, 134(3):307-313.
12. Fuji H, Noda T, Sairenchi T, Muto T: **Daily intake of green and yellow vegetables is effective for maintaining bone mass in young women**. *Tohoku J Exp Med* 2009, 218(2):149-54.
13. HSE (2003): **Health survey for England: the health of young people '95–97**. http://www.dh.gov.uk/PublicationsAndStatistics/PublishedSurvey.
14. PND (2003): **Publication of national diet and nutrition survey of young people aged 4–18**. http://www.foodstandards.gov.uk/news/pressreleases/nationaldiet.
15. Mahmood M, Saleh A, Al-Alawi F, Ahmed F: **Health effects of soda drinking in adolescent girls in the United Arab Emirates**. *J Crit Care* 2008, 23(3):434-240.
16. Nielsen SJ, Popkin BM: **Changes in Beverage Intake between 1977 and 2001**. *Am J Prev Med* 2004, 27:205–210.
17. Gerrior S, Putnam J, Bente L: **k and milk products: their importance in the American diet**. *Food Rev* 1998, 29–37.
18. Jacobson M: **Liquid candy. 2. Washington, DC: Center for Science in the Public Interest** 2005.
19. **American Beverage Association What America drinks** 2008. http://improveyourhealthwithwater.info/a1/whatamericadrinks.pdf
20. Collison KS, Zaidi MZ, Subhani SN, Al-Rubeaan K, Shoukri M, Al-Mohanna FA: **Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children**. *BMC Public Health* 2010, 10:234.
21. Garrow JS, Webster J: **Quetelet's index (W/H^2) as a measure of fatness**. Int J Obes 1985, 9:147–153.
22. BeamMed made by (sunlight) 7000/8000 series, Type/CSB serial No.5718, 2004. http://www.medwow.com/used-bone-densitometer-ultrasound/sunlight/omnisense-7000s/943971384.item
23. The Bodystat®1500 BeamMed made by (sunlight) 7000/8000 series, Type/CSB serial No.5718. http://www.bodystat.com/products/1500_sports_and_fitness.php
24. SPSS: **Statistical Package for Social Science, Computer Software, IBM, SPSS Ver. 16.0 in 2008**. SPSS Company, London, UK 2008.
25. Lips P: **Vitamin D deficiency and secondary hyperparathyroidism in the elderly: consequences for bone loss and fractures and therapeutic implications**. *Endocr Rev* 2001, 22:477–501.
26. Heaney RP, Abrams S, Dawson-Hughes B, Looker A, Marcus R, Matkovic V et al.: **Peak bone mass**. *Osteoporos Int* 2000, 11:985–1009.
27. Saggese G, Baroncelli GI, Bertelloni S: **Osteoporosis in children and adolescents: diagnosis, risk factors, and prevention**. *J Pediatr Endocrinol Metab* 2001, 14:833–59.
28. Harris AC, Doucette WR, Reist JC, Nelson KE: **Organization and results of student pharmacist bone mineral density screenings in women**. *J Am Pharm Assoc* 2003, 51(1):100-104.
29. ElMaghraoui A, Ghazi M, Gassim S, Ghozlani I, Mounach A, Rezqi A, Dehhaoui M: **Risk factors of osteoporosis in healthy Moroccan men**. *BMC Musculoskelet Disord* 2010, 11:148.
30. Hallström H, Melhus H, Glynn A, Lind L, Syvänen A, Michaëlsson K: **Coffee consumption and CYP1A2 genotype in relation to bone mineral density of the proximal femur in elderly men and women: a cohort study**. *Nutr Metab* 2010, 7:12.
31. NOF (2011). National Osteoporosis Foundation: **How the Foods You Eat Affect Your Bones**. http://www.nof.org/aboutosteoporosis/prevention/foodandbones
32. Bray GA, Nielsen SJ, Popkin BM: **Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity**. *Am J Clin Nutr* 2004, 79:537–543.
33. Gurthrie JF, Morton JF: **Food sources of added sweeteners in the diets of Americans**. *J Am Diet Assoc* 2000, 100:43–51.
34. Heller K, Burt BA, Eklund SA: **Sugared soda consumption and dental caries in the United States**. *J Dent Res* 2001, 80:1949–1953.
35. Raben A, Vasilaras TH, Moller AC, Astrup A: **Sucrose compared with artificial sweeteners: different effects on ad libitum food intake and body weight after 10 wk of supplementation in overweight subjects**. *Am J Clin Nutr* 2002, 76:721–729.
36. Ma D, Jones G: **Soft drink and milk consumption, physical activity, bone mass, and upper limb fractures in children: A population-based case-control study**. *Calcif Tissue Int* 2004, 75:286–291.
37. Wyshak G: **Teenaged girls, carbonated beverage consumption and bone fractures**. *Arch Pediatr Adolesc Med* 2000, 154:610–613.
38. McGartland C, Robson PJ, Murray L, Cran G, Savage MJ, Watkins D, Rooney M, Boreham C: **Carbonated soft drink consumption and bone mineral density in adolescence: the Northern Ireland Young Hearts project**. *J Bone Miner Res* 2003, 18:1563–1569.
39. Mahmood M, Saleh A, Al-Alawi F, Ahmed F: **Health effects of soda drinking in adolescent girls in the United Arab**

Emirates. *J Crit Care* 2008, 23(3):434-440.

40. Mei Z, Grummer-Strawn LM, Pietrobelli A, Goulding A, Goran MI, Dietz WH: **Validity of body mass index compared with other body-composition screening indexes for the assessment of body fatness in children and adolescents**. *Am J Clin Nutr* 2002, 7597–985.
41. Holmes BL, Ludwa IA, Gammage KL, Mack DE, Klentrou P: **Relative importance of body composition, osteoporosis-related behaviors, and parental income on bone speed of sound in adolescent females**. *Osteoporos Int* 2010, 21(11): 1953-1957.
42. Andreoli A, Bazzocchi A, Celi M, Lauro D, Sorge R, Tarantino U, Guglielmi G: **Relationship between body composition, body mass index and bone mineral density in a large population of normal, osteopenic and osteoporotic women**. *Radiol Med* 2011, 116(7):1115-1123.
43. Cobayashi F, Lopes LA, Taddei JA: **Bone mineral density in overweight and obese adolescents**. *J Pediatr* 2005, 81(4): 337-342.
44. Ho-Pham LT, Nguyen ND, Lai TQ, Nguyen TV: **Contributions of lean mass and fat mass to bone mineral density: a study in postmenopausal women**. *BMC Musculoskelet Disord* 2010, 11:59.
45. Reid IR: **Relationships among body mass, its components, and bone**. J Bone 2002, 31:547–555.
46. Wang MC *et al.*: **The relative contributions of lean tissue mass and fat mass to bone density in young women**. J *Bone* 2005, 37:474–481.
47. Premaor MO, Pilbrow L, Tonkin C, Parker RA, Compston J: **Obesity and Fractures in Postmenopausal Women**. *J Bone Mineral Res* 2010, 25(2):292–297.
48. Gimble JM *et al.*: **The function of adipocytes in the bone marrow stroma: an update**. *J. Bone* 1996, 19:421–428.
49. Cohen PG: **Aromatase, adiposity, aging and disease. The hypogonadal-metabolic-atherogenicdisease and aging connection**. *J Med Hypotheses* 2001, 56: 702–708.
50. Li X *et al.*: **Steroid effects on osteogenesis through mesenchymal cell gene expression**. *J Osteoporos Int* 2005, 16:101–108.
51. Van Staa TP *et al.*: **The epidemiology of corticosteroid-induced osteoporosis: a meta-analysis**. *J Osteoporos Int* 2002, 13:777–787.
52. Lan-Juan Z, Yong-Ju,n L, Peng Yuan L, James H, Robert R, Hong-Wen D: **Relationship of obesity with osteoporosis**. *J Clin Endocrinal Metab* 2007.
53. Rozman C. *et al.*: **Age-related variations of fat tissue fraction in normal human bone marrow depend both on size and number of adipocytes: a stereological study**. *J Exp Hematol* 1989, 17:34–37.
54. Justesen J *et al.*: **Adipocyte tissue volume in bone marrow is increased with aging and in patients with osteoporosis**. *J. Biogerontology* 2001, 2:165–171.
55. Verma S *et al.*: **Adipocytic proportion of bone marrow is inversely related to bone formation in osteoporosis**. *J Clin Pathol* 2002, 55:693–698.
56. Rosen CJ *et al.*: **Congenic mice with low serum IGF-I have increased body fat, reduced bone mineral density, and an altered osteoblast differentiation program**. *J. Bone* 2004, 35:1046–1058.

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