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Association between Soft Drink Consumption and Bone Mineral Density among Qatari Women- Analysis of Qatar Biobank Data

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ABSTRACT

Background: Decrease in bone mineral density (BMD) increases the risk of osteopenia and osteoporosis. It is common in older women, as the BMD tends to decrease with age, particularly after menopause. While age and hormonal changes are well-established risk factors, other factors have been investigated for possible links to increase the risk of osteoporosis. These factors include dietary patterns and lifestyle.

Aim: To explore the association between soft drink consumption and BMD.

Method: This cross-sectional study included data from 1000 Qatari women age ≥ 40 year's participated in the Qatar Biobank Study. BMD levels were measured using the Dual-Energy X-ray Absorptiometry (DXA) scan and the soft drink consumption was assessed using a food frequency questionnaires. Multiple quantile regression models were used to assess the association between bone mineral density and soft drink consumption.

Results: While most of the participants did not drink soft drinks (68%), around one third reported consuming soft drinks. A total of 16.4% of participants reported consuming soft drinks < 1 time/ week and 15.6% of participants reported consuming soft drinks ≥ 1 time/ week. There was an inverse association between BMD and soft drink consumption. Compared with non-consumers, ≥ 1 time/week consumption of soft drink had a β-0.034 95%CI (-0.056, -0.012) at 0.25 quantile for BMD after adjusting for age, BMI, menopausal status, smoking status, physical activities, milk intake, and fruit and vegetable consumption. Also, BMD was negatively associated with regular soft drinks, but not with diet soft drink and energy drink.

Conclusion: High consumption of soft drink is inversely related to BMD among Qatari women. Further longitudinal and clinical studies are required before developing public health intervention to improve bone health by reducing soft drink consumption.

INTRODUCTION

The musculoskeletal disorders are one of the most common non-communicable diseases (NCD) that lead to severe long-term physical disability, pain and decreased quality of life. With the rapid increase in longevity, osteoporosis, in particular, is viewed as a global problem and recognized to be the most common disease in old age population.[1] Global burden of NCDs represented by osteoporotic fractures was reported to be around 9 million fractures per year.[2] The most affected individuals are older and post menopausal women[3] and about 200 million women estimated to be affected annually by osteoporosis, worldwide.[4] Recent study showed that osteoporosis among Qatari postmenopausal women was 12.3% and the BMI was higher among postmenopausal women compared to premenopausal women.[5]

The Framingham osteoporosis study results revealed that Cola intake associated with significantly lower BMD hip site only among women. The results were similar in case of diet cola and weak for decaffeinated cola.[6] Also, a study exploring the association between soft drink consumption and multiple morbidity among South Australian adults found a negative effect of soft drink consumption on range of health outcome including osteoporosis.[7] similarly, a study conducted on Arabian women sample found that T-score and Z-score of BMD were inversely associated with soft drink intake and positively with milk, and dairy products consumption, calcium, and vitamin D supplementation use, and exercise. [8]

METHODOLOGY

The study uses secondary data collected by Qatar BioBank (QBB) to explore the association between soft drink consumption and bone mineral density among Qatari women. A sample size of 1000 Qatari females aged ≥ 40 years were made available by QBB for this study. The sample size computation was determined using NCSS PASS version 14 (NCSS LLC, Kaysville, Utah).

The data collected primarily by well-trained QBB personnel using the most validated instruments available. Data collected using questionnaire included lifestyle, clinical information and further biological samples were also obtained from the participants.

The inclusion criteria for this study were female Qatari participants, aged ≥ 40 years at the time of recruitment. Participants have been recruited within the last five years with no missing records on the primary outcome bone mineral density or the main predictor soft drink consumption.

Any women who were pregnant at the time of the survey were also excluded. In the current study, the primary outcome of interest is total body BMD values (g/cm2) for each participant obtained using dual-energy x-ray absorptiometry (DXA) GE scan. The primary predictor variable is the frequency of the soft drink consumptions that include regular soft drink, diet soft drink, and energy drink.

These data were extracted from QBB food frequency questionnaire which included questions on dietary intake in general, consumption of various types of drinks, and eating habits. Other data about other covariate were collected via self reported questionnaire. Multiple linear regression was used first to explore the association, but most importantly, the effect of the soft drink consumption on lowest quantiles of BMD was evaluated using multivariate quantile regression models.

RESULTS

The study reveled that the highest consumption was seen among age group 40-50, while the lowest was among participants over 70. Contrarily, as the income increase the soft drink consumption among participants increased. Soft drink consumption was higher among participants with university degree or higher followed by those below secondary school educations and lower among those with post-secondary. Participants diagnosed with rheumatoid arthritis, diabetes, gestational diabetes, thyroid disease, kidney disease, osteoporosis, and asthma have low consumption of soft drink compare to those free of the disease. The main predictor and related dietary intake were described in Table 5. The mean consumption of fruits and vegetables was 9.4 times per week (SD= 6.0).

Table 5
Distribution of diet-related variables of the study sample (n=1000)

Variables	N (%)
Total Consumption of Fruit Drinks	
o 3-4 times per week	247 (24.7)
o 5-6 times per week	392 (39.2)
o 7 or more times per week	361 (36.1)
Total Consumption of Soft Drinks	
o 0 per week	680 (68.0)
o <1 time per week	164 (16.4)
o >1 time per week	156 (15.6)
Total Consumption of Milk	
o Less than 4 times per week	378 (37.8)
o 4-5 times per week	320 (32.0)
o 6 or more times per week	302 (30.2)
Fruit and Vegetable intake*	9.4 (6.0)

*: mean (SD)

In our study, those in the lowest quantile for BMD were assumed to represent women with low BMD and in turn with high-risk of osteoporosis. Age, BMI, menopausal status, multivitamin or minerals use, consumption of milk and education level were found to be statistically associated with BMD in the univariate analysis and were included in the model building. The main predictor and the other clinically significant variables such as smoking status and fruit and vegetable consumption were also added to adjust for in the model. Also, farther adjustment for consumption of milk and leisure time physical activity to the previous model was made. Even after further adjusting for both total consumption of milk and leisure time physical activity by adding them to the previous model, the results revealed a statistically significant inverse association in the 25th percentiles of the BMD distribution with the total soft drink consumption of more than one time per week. Each increase in soft drink consumption per week was associated with a BMD decrease of -0.034 (95%CI (-0.056, -0.012)) in the 0.25 quantile. Table 14 show the soft drink consumption was negatively associated with BMD only after adjusting for age and BMI in model 2 . Sensitivity analysis shows that there was a significant inverse association between the regular soft drink consumption and the BMD at 0.25 quantile of the distribution.

Table 14
Coefficient regression (95% CI) for BMD by soft drink consumption levels*

Predictor	Bone Mineral Density Q (0.25)			
	Coefficient	p-value	95% CI	
Model 1				
Non-consumers	0.00			
o <1 time per week	-0.001	0.926	-0.031	0.028
o >1 time per week	-0.021	0.162	-0.051	0.009
Model 2				
Non-consumers	0.00			
o <1 time per week	0.003	0.784	-0.020	0.026
o >1 time per week	-0.024	**0.041**	-0.048	-0.001
Model 3				
Non-consumers	0.00			
o <1 time per week	0.001	0.933	-0.020	0.022
o >1 time per week	-0.043	**0.001**	-0.065	-0.022
Model 4				
Non-consumers	0.00			
o <1 time per week	-0.005	0.798	-0.045	0.034
o >1 time per week	-0.040	**0.063**	-0.082	0.002

*Model 1: adjust for age.
*Model 2: further adjust for adjust for BMI.
*Model 3: further adjust for education, income, menopause status, multivitamin or minerals, total consumption fruits drink consumption, smoking status, total consumption of milk, diabetes, and asthma.
*Model 4: adjust for age, BMI, education, income, menopause status, multivitamin or minerals, total consumption fruits drink consumption, smoking status, total consumption of milk, and excluding those already diagnosed with osteoporosis.

Subgroup analyses, soft drink consumption was inversely associated with the BMD at the 0.25 quantile mostly when the consumption was more than one time per week. The findings were observed among age group (40-50) years old and among those (51-60) years old, participants with education below secondary school and participants with postgraduate education, and among those pre-menopause and participants undergo a hysterectomy. Also, showed that soft drink consumption was inversely associated with the BMD at the 0.25 quantile mostly when the consumption was more than one time per week among those without diabetes, osteoporosis, thyroid disease, kidney disease, and rheumatoid disease. Also, among participants who were overweight, not physically active, and non-smokers not taking multivitamin or minerals or on HRT .
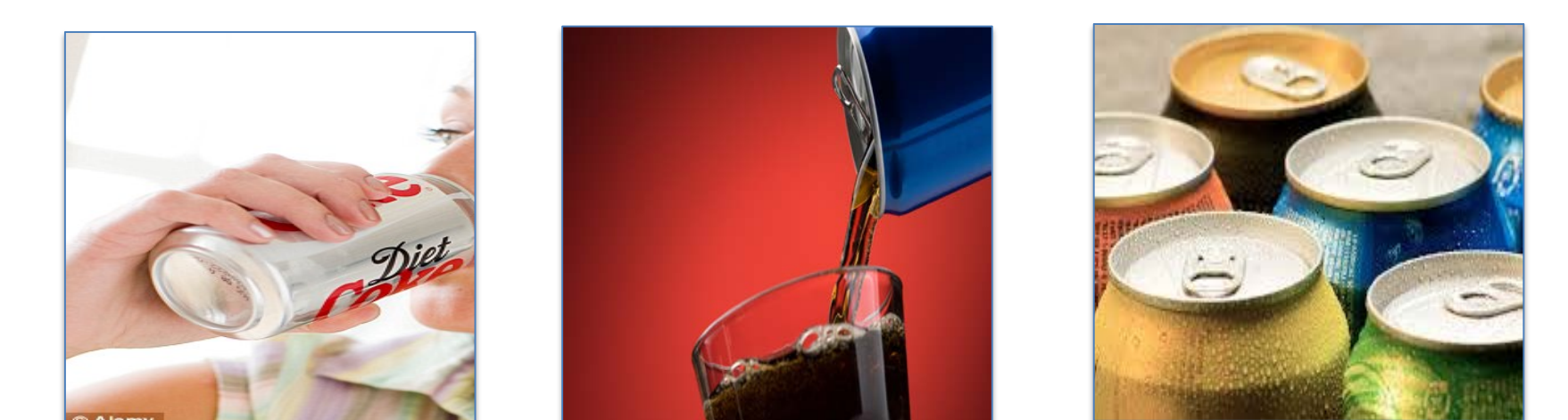
Discussion

The purpose of the current study is to investigate the association between soft drink consumption and bone mineral density among Qatari women age age 40 years or older. Evidence from previous studies suggested that soft drink consumption has negative consequences on bone mineral density. Our findings were consistent with those results[6]; it indicates a statistically significant negative association between soft drink consumption when all types of soft drink were combined. Compared with non-consumers of soft drink, weekly consumers had a lower bone mineral density. Although a high proportion of the participants did not consume soft drink, more than 15% consumed on a weekly basis.

CONCLUSION

This study emphasized on the possible consequences of soft drink consumption on the overall bone health by exploring the associations between soft drink consumption and BMD. The results showed that about 16.4 percent of participants reported consuming soft drinks less than one time per week, while 15.6 percent of participants reported consuming soft drinks more than one time per week. Our findings suggest that there was a clinically and statistically significant association between BMD and soft drink consumption after adjusting for age, BMI, menopausal status, smoking status, physical activities, milk intake, and fruit and vegetable consumption. Additionally, the results revealed that soft drink consumption >1 time/week decrease BMD more than 10 years aging (getting older from 40-50 to 51-60). Also, in our attempt to understand the relation between type of soft drink consumption and BMD, we found that BMD was significantly negatively associated with regular soft drink, but not with diet and energy soft drink. Further high-quality studies with long term follow up with specific purpose of testing the hypothesis are warranted before we can comment on potential causal association.

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