Journal of Aging Research & Clinical Practice©
Volume 2, Number 4, 2013

AGE AND MILK CONSUMPTION ARE ASSOCIATED WITH VITAMIN D STATUS IN PRE-MENOPAUSAL SAUDI WOMEN

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Abstract: *Background:* There is little evidence published on the prevalence of vitamin d deficiency among Saudi women, in spite of the widespread food fortification and the excellent opportunity of available sun light all over the year. The present cross-sectional study aims to determine the prevalence and risk factors of vitamin D deficiency among premenopausal women visiting commercial centers in Riyadh City. *Materials and Methods:* A quasi-random technique was employed in the recruitment of subjects from various commercial Malls in Riyadh last May-November, 2012. A total of 256 subjects filled a general questionnaire, height and weight were measured and blood extracted ascertaining total 25-hydroxyvitamin D, calcium, phosphorous and alkaline phophatase from a vitamin D External Quality Assessment (DEQAS)-certified laboratory. *Results:* Vitamin D deficiency (< 50 nmol/L) was noted in 200 (77.6%) of subjects. Age and milk consumption were the significant predictors of vitamin D status, with 33.9% of variance perceived ($p < 0.001$). Increased BMI, being married and the presence of muscle pain were all significantly associated with vitamin D deficiency. *Conclusion:* Nearly 4 out of 5 premenopausal Saudi women shoppers harbor vitamin D deficiency and this is influenced by age and milk consumption. It is clear that the general female public faces an imminent threat of vitamin D deficiency-related diseases unless aggressive public awareness is conducted.

Key words: Vitamin D, vitamin D deficiency, milk consumption, ages.

Introduction

The vitamin D deficiency pandemic has been recently recognized for its pleiotropic effects outside skeletal and calcium homeostasis (1). Specifically in the Middle East, a plethora of chronic, non-communicable diseases have been linked to vitamin D deficiency including diabetes mellitus type 2 (DMT2), obesity and the metabolic syndrome (2-4). Not surprisingly, the extent of vitamin D deficiency has not spared Arab children, and has been significantly associated with a roster of cardiometabolic risk factors as early as pre-adolescence (5).

Despite overwhelming evidence, the local scientific and medical community remained cautious on translating local findings to routine clinical management among patients at highest risk for vitamin D deficiency, probably secondary to the lack of standardized methods employed in the measurement of vitamin D status (6), and possibly because of the lack of association between important clinical measurements such as parathyroid hormone (PTH) and degree of vitamin D deficiency severity in the Saudi population (7, 8). It is apparent therefore that future studies pertaining to vitamin D in deficient populations be done in accredited institutions to merit credibility of findings as well as to confirm previous reports.

In this present cross-sectional study, we aimed to determine the prevalence of vitamin D deficiency among apparently healthy pre-menopausal Saudi women visiting the various commercial centers of Riyadh using a quasi-random selection technique, and to identify significant predictors of vitamin D status utilizing a DEQAS-approved laboratory in King Saud University, Riyadh, KSA.

Methodology

In this cross-sectional study conducted at multiple shopping malls of Riyadh, Saudi Arabia, a total of 256 non-pregnant Saudi women aged 15-55 years were

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Received August 28, 2013
Accepted for publication September 25, 2013

randomly recruited using the quasi-random sampling technique. Subject recruitment, data and sample collection were done during the months of May to November 2012. Subjects were given free pamphlets and brochures containing general knowledge about vitamin D and its importance to health. Those with existing non-chronic communicable diseases that were otherwise stable were included to avoid selection bias. Pregnant women, expatriates and non-consenting subjects were excluded from participation.

Ethical consideration

Approval was obtained from The Review Board at King Fahad Medical City (IRB Log Number: 12-236). Written informed consent was given by each participant. Subjects were notified via SMS their results and were advised and referred accordingly to specialists.

Data and Blood Collection

Subjects filled up a general questionnaire covering demographic data, medical history of chronic illnesses, current complaints of symptoms related to vitamin D and calcium deficiency, intake of common vitamin D- and calcium-rich foods, sun exposure and smoking history. Height (cm) and weight (kg) were measured with the patient barefoot using a standardized stadiometer. Body Mass Index (BMI) was calculated as weight (kg) divided by height in squared meters. Venous blood sample (5cc) was withdrawn from each subject by a trained female nurse. Blood samples were centrifuged and serum samples separated. Both blood and serum samples were placed in plain polystyrene tubes and were delivered to Prince Mutaib Chair for Biomarkers of Osteoporosis (PMCO) Laboratory in King Saud University, Riyadh, Saudi Arabia for storage at -20'C and for analysis. Serum calcium, phosphorous, and alkaline phosphatase were measured using standard analytical techniques (Konelab, Espoo, Finland). Serum total 25-hydroxyvitamin D was measured using Roche Diagnostics (e-Cobas 411) under a DEQAS (Vitamin D External Quality Assessment) certified laboratory (PMCO).

Vitamin D Cut-offs

Vitamin D deficiency was defined as having circulating levels of 25-OHD levels below 50nmol/L, insufficiency between 50-74 nmol/L and sufficiency at ≥ 75nmol/L (9).

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences version 16.0 (SPSS, Chicago IL, USA). Categorical variables were presented as frequencies and percentages. Continuous variables exhibiting normal distribution were presented as mean ± standard deviation. A Non-Gaussian variable, alkaline phosphatase was presented as median (inter-quartile range). Spearman correlation was used to determine the relationship between total 25-Hydroxyvitamin D and the variables measured. Step-wise linear regression using total 25-hydroxyvitamin D as dependent variable and all the variables measured as independent variables was used to determine significant predictors. Power size calculation was done using the prevalence of vitamin D deficiency and revealed that a sample size of N= 245 can achieve the power of 80% at alpha = 0.05. P-value set at $p < 0.05$.

Table 1
Demographic and Clinical Characteristic of Patients

Parameter	
N	256
Age (years)	30.69 ± 10.44
Body Mass Index	29.2 ± 9.9
Smoking	4 (1.5)
Demographics	
Job	
Student	54 (21.1)
Unemployed	137 (53.5)
Administrative Work	10 (3.9)
Professional (Teacher, nurse, physician…)	55 (21.5)
Marital Status	
Single	107 (41.8)
Married	134 (52.3)
Divorced	8 (3.1)
Widow	7 (2.7)
Physically Active	66 (25.7)
Clinical Symptoms	
Muscle Pain	136 (53.3)
Back Pain	162 (63.5)
Toothache	99 (37.2)
Joint Pain	139 (54.5)
Bone Fracture	22 (8.6)
Medical History	
Diabetes Mellitus Type 2	24 (9.4)
Hypertension	18 (6.8)
Asthma	16 (6.4)
Osteoporosis	9 (3.5)
Cancer	0 (0)
Liver Diseases	3 (1.2)
Kidney Diseases	1 (0.3)
Biochemistry	
25-Hydroxyvitamin D (nmol/L)	39.11 ± 2.89
Calcium	2.07 ± 0.17
Phosphorous	1.06 ± 0.21
Alkaline Phosphatase#	1.34 (1.09-1.66)

Note: # Denotes non-Gaussian Distribution and presented as median (inter-quartile range).

Results

Using the cut-offs mentioned previously, 77.6% of subjects had vitamin D deficiency, 9.1% had insufficiency, and only 13.3% were vitamin D sufficient (not mentioned in tables). Table 1 shows the general characteristics of subjects. The mean age was 30.7 ± 10.4 and mean BMI was within the over-weight/obese category (29.2 ± 9.9). More than half of the subjects considered themselves as unemployed and married. Among the clinical symptoms, more than 60% of the subjects had back pain and more than 50% had muscle and joint pains. 24 (9.4%) of the subjects had DMT2, while another 18 (6.8%) had hypertension (Table 1). Table 2 shows that only 33.5% of the subjects declared having direct exposure to sunlight, and among them only 40 (15.6%) subjects were exposed to sunlight in more than 2 sites. Majority of the subjects (65.6%) had a brown skin color. Furthermore, majority of the subjects eat foods rich in vitamin D such as fish, egg, milk and mushroom only once or twice in their weekly diet (Table 2). Stepwise linear regression revealed that increasing age and higher milk consumption were the significant predictors total 25-Hydroxyvitamin D in the cohort, with an adjusted R2 of 0.11, or 33.9% of variance perceived (p-value < 0.001) (not mentioned in tables). Figure 1 shows the positive and significant trend between milk consumption and vitamin D status with increasing age (p = 0.018).

Table 2
Skin color, Sun Exposure and Diet

Skin Color	
White (1-2)	68 (26.6)
Brown (3-4)	168 (65.6)
Black (5-6)	20 (7.8)
Direct Exposure to Sun	86 (33.5)
Parts Exposed	
Face	28 (10.9)
Arms	12 (4.7)
Legs	6 (2.3)
More than one site of exposure	40 (15.6)
Number of Exposure	
Less than twice per week	45 (17.6)
2-3 times per week	28 (10.9)
4 or more times per week	16 (6.2)
Time of Exposure	
Morning	39 (15.2)
Noon	31 (12.1)
Afternoon before sunset	24 (9.4)
Fish Consumption	
Once-twice per week	249 (97.3)
3-5 times per week	7 (2.7)
More than 6 times per week	0 (0)
Egg Consumption	
Once-twice per week	201 (78.8)
3-5 times per week	30 (11.8)
More than 6 times per week	25 (9.4)
Milk Consumption	
Once-twice per week	150 (58.8)
3-5 times per week	40 (15.7)
More than 6 times per week	66 (25.5)
Mushroom Consumption	
Once-twice per week	248 (96.9)
3-5 times per week	8 (3.1)
More than 6 times per week	0 (0)

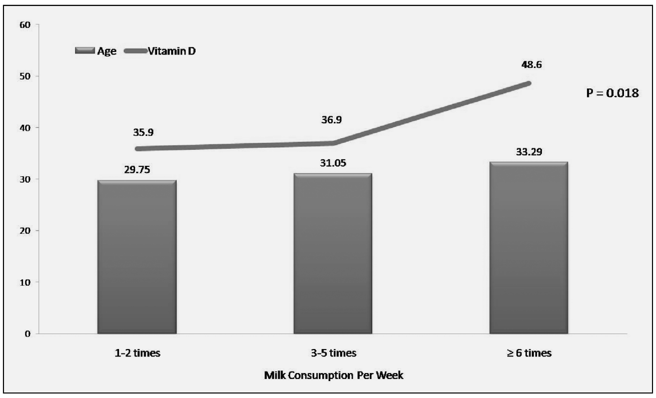
Note: Data presented as N (%).

Table 3
Significant Bivariate Associations Using Total 25-Hydroxyvitamin D as a Dependent Variable

Parameter	Coefficient	P-value
Age	0.224	< 0.001
BMI	0.144	0.036
Marital Status	0.171	0.008
Muscle Pain*	-0.124	0.054
Milk Consumption	0.147	0.023
Phosphorous	0.158	0.014

Note: * denotes borderline significance; p-value significant at p < 0.05.

Figure 1
Significant parallel increase in milk consumption versus age and vitamin D status



Discussion

Almost all studies conducted with respect to vitamin D deficiency in Saudi Arabia utilized subjects visiting primary health care centers (3, 4), or subjects with known diseases such as DMT2 (9), sickle cell disease (10) and systemic lupus erythematosus (11), amongst others. While the present study highlights yet again the extremely high prevalence of vitamin D deficiency among Saudi women, this is one of the first studies to highlight vitamin D deficiency among women recruited from the general consumer population. With a staggering 77.6% of pre-menopausal Saudi women considered as vitamin D deficient, the present study also reveals that very limited intervention has been done by the Saudi public health community, despite a plethora of evidence pointing to increased prevalence of vitamin D deficiency as far back as 1984 (12).

The high prevalence of vitamin D deficiency in Saudi Arabia has been attributed to some well-known factors such as extreme weather conditions (13), lower than recommended intakes of dietary calcium and vitamin D (14), and veiled clothing (15, 16). Other factors such as marital status and obesity (3, 17) in relation to vitamin D deficiency were also confirmed in the present study. A novel finding observed in this cross-sectional study was the significant association of vitamin D status and milk consumption, and this association persisted even after adjusting for all measured variables. It appears that for the Saudi female population, at least, the major source of vitamin D is dietary in nature and not direct sun exposure. Milk is a top food source for vitamin D in the Northern Hemisphere countries (18) and a mainstay recommendation for vitamin D correction of the 2013 European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO) (19). In Saudi Arabia however, preferred beverages include coffee and tea, which fortunately and only recently, have also been positively linked with improved vitamin D status, at least in adolescents (20). Similarly, milk consumption is not common among young Saudi women as opposed to their older counterparts, which probably explains why vitamin D deficiency is also more common in in the younger age group.

Another interesting finding is the association of low vitamin D status and the presence of muscle pain. While considered as "non-specific", muscle pain related disorders, including fibromyalgia, have been previously linked with vitamin D deficiency among Saudi women (21, 22). However, whether correction of vitamin D status reverses pain amongst this population is still not established in current literature.

The study acknowledges some limitations. The cross-sectional design limits the findings of the study to at best, suggestive. Furthermore, information collected from the questionnaires was self-administered and maybe subject to bias. No information was collected on the type of dairy products consumed as to whether it was fortified or not. Nevertheless, the study has several strengths since the subjects recruited were from the general public, and the quasi-random technique adds further strength to the validity of findings.

In conclusion, the present study highlights and confirms the extreme prevalence of vitamin D deficiency among premenopausal Saudi women using an internationally accredited standard laboratory for vitamin D measurement. Increasing age and milk consumption are significant predictors for vitamin D status in this cohort. Increased vigilance in the creation of public health awareness about vitamin D deficiency is needed with the hope that it will elicit the necessary effect in reversing the present epidemic.

Acknowledgments: The authors are grateful to the medical team who helped in the recruitment of subjects, installation of booths in the malls and distribution of brochures to the general public in creating vitamin D deficiency awareness. The authors are also grateful to Faculty of Medicine, King Fahad Medical City for funding this study as well as Prince Mutaib Chair for Biomarkers of Osteoporosis for the technical support.

Conflict of Interest: The authors declare no conflict of interest.

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