

# Vitamin D Status in Healthy Omani Women of Childbearing Age

Study of female staff at the Royal Hospital, Muscat, Oman

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## حالة فيتامين (د) عند النساء العُمانية السليمات في عمر الإنجاب دراسة النساء العاملات في المستشفى السلطاني بمسقط (عُمان)

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**المخلص:** الهدف: التعرض لأشعة الشمس له دور حيوي في تكوين فيتامين (د)، وعلى الرغم من أن نقص فيتامين (د) قد تم توثيقه في المناطق المعتدلة، غير أن هناك ندرة في مثل هذه الدراسات في المناطق الاستوائية التي يتفادى فيها السكان التعرض لأشعة الشمس لأسباب عديدة. الهدف من هذه الدراسة هو معرفة مستوى 25 هيدروكسي فيتامين (د) ومدى علاقته مع شاكلة الكيمياء الحيوية للعظام وفترة التعرض لأشعة الشمس وكمية فيتامين (د) المتناول عن طريق الغذاء عند النساء العُمانية السليمات في عمر الإنجاب. الطريقة: ضمت هذه الدراسة التي أجريت في شهر ديسمبر (2006) 41 من النساء العُمانية السليمات ظاهريا، العاملات في المستشفى السلطاني بمسقط، واللاتي تتراوح أعمارهن ما بين 18-45 سنة (المتوسط  $\pm$  الانحراف المعياري)  $29 \pm 6$  سنوات. تم ملء استبيان بخصوص فترة التعرض لأشعة الشمس وكمية الغذاء المتناول ونوع الملابس، وتلا ذلك أخذ عينات دم منهن لقياس مستوى 25 هيدروكسي فيتامين (د) والكالسيوم والفوسفات أنزيم الفوسفاتيز القلوي وهرمون الغدد الدرقية. النتائج: كان مستوى 25 هيدروكسي فيتامين (د) عند جميع النساء أقل من المستوى التشخيصي لنقص الفيتامين (50 نانومول/لتر)، كما ظهر أن هناك ترابطا معتدا إحصائيا بين مستوى 25 هيدروكسي فيتامين (د) مع قلة التعرض لأشعة الشمس (25 هيدروكسي فيتامين (د)  $r = 0.672$ ,  $P < 0.01$ ) ومع كمية الغذاء المتناول الحاوي علي فيتامين (د) (25 هيدروكسي فيتامين (د)  $r = 0.482$ ,  $P < 0.001$ ). الخلاصة: قد يكون نقص 25 هيدروكسي فيتامين (د) دون المستوى السريري منتشرا بين النساء العُمانية. من المهم الانتباه لعوامل الاختطار مثل قلة التعرض لأشعة الشمس عند هؤلاء النساء، وفي حالة عدم إمكانية زيادة فترة التعرض لأشعة الشمس، يوصى بالاستعانة بتناول العقاقير الفموية الحاوية على الفيتامين لتجنب جميع النتائج والمضاعفات الناتجة عن نقصي فيتامين (د).

كلمات المفتاح: نقص فيتامين (د)، 25 هيدروكسي فيتامين (د)، نساء، أشعة الشمس، عُمان.

**ABSTRACT: Objectives:** Sunlight exposure has a vital role in vitamin D synthesis. Although vitamin D deficiency has been well documented in temperate zones, studies have been scarce in tropical countries where the population is well covered and for various reasons avoids sun exposure. The objective of this study was to investigate serum 25-hydroxyvitamin D [25(OH)D] levels and its relationship to biochemical bone profile, exposure to sunlight and vitamin D intake amongst Omani women of childbearing age. **Methods:** 41 apparently healthy women working at the Royal Hospital, Muscat, Oman and aged 18–45 years, with mean  $\pm$  SD of  $29 \pm 6$  years, were included in this study conducted in December 2006. They completed a questionnaire regarding the duration of sun exposure, food intake and type of clothing worn. Blood samples were collected from them and analysed for serum 25(OH)D, calcium, phosphate, alkaline phosphatase and parathyroid hormone levels. **Results:** All the women had a 25(OH)D level  $< 50$  nmol/L as the cut-off for deficiency. 25(OH)D levels were strongly correlated with the lack of sun exposure ( $r = 0.672$ ,  $P < 0.001$ ) and a significant correlation was also found between 25(OH) D level and food intake ( $r = 0.482$ ,  $P < 0.01$ ). **Conclusion:** Subclinical 25(OH)D deficiency may be prevalent amongst Omani women. Risk factors such as poor sunlight exposure should be addressed in women of childbearing age and, if increased sunlight exposure is not possible, oral supplementation should be considered to avoid all the consequence and complications of vitamin D deficiency.

**Keywords:** Vitamin D deficiency; 25-hydroxyvitamin D; Women; Sunlight; Oman

### ADVANCES IN KNOWLEDGE

1. Vitamin D deficiency may be prevalent among Omani women mainly due to poor sunlight exposure.
2. This study stimulates the need for further studies to identify the prevalence of metabolic bone diseases among Omanis.

**APPLICATION TO PATIENT CARE**

1. This study highlights important public health issues such as the need for adequate maternal vitamin D levels in pregnancy/lactation and the promotion of outdoor activities.

VITAMINS D IS PRODUCED ENDOGENOUSLY by the exposure of skin to sunlight, and absorbed from food containing or supplemented with vitamin D. When it penetrates the skin, ultraviolet light is converted from 7-dehydrocholesterol to vitamin D<sub>3</sub>. Vitamin D from the skin or diet is metabolised in the liver to 25-hydroxyvitamin D [25(OH)D], then further metabolism occurs in the kidney to form the active form 1,25-dihydroxyvitamin D [1,25(OH)2D]. The renal production of 1,25(OH)2D is tightly regulated by plasma parathyroid hormone levels as well as serum calcium and phosphate levels.<sup>1</sup> Deficiency of vitamin D results in rickets in children and osteomalacia, muscle weakness and increased risk of fractures in adults.<sup>1</sup>

The discovery that most tissues and cells in the body have vitamin D receptors and some of them have the enzymatic capability to convert vitamin D to its active form, 1,25(OH)2D, may explain the important role of vitamin D in skeletal and non-skeletal health. Vitamin D also plays a role in decreasing the risk of chronic conditions such as diabetes, cancer, and autoimmune, infectious and cardiovascular diseases.<sup>2,3</sup>

Vitamin D deficiency is a well-recognised epidemic problem worldwide. Given the significant role of sunlight in vitamin D synthesis, it is quite logical to suggest a low prevalence of vitamin D deficiency in tropical countries. However, studies carried out in the last two decades have shown a high prevalence of vitamin D deficiency in many tropical countries such as Turkey,<sup>4</sup> Iran,<sup>5</sup> Saudi Arabia,<sup>6,7,8,9</sup> United Arab Emirates,<sup>10</sup> Kuwait,<sup>11</sup> Bangladesh<sup>12</sup> and Tunisia.<sup>13</sup>

Vitamin D status has so far been poorly documented in the Omani population. The present study aimed to investigate vitamin D levels among Omani females of childbearing age where a sufficient level is important to prevent neonatal hypocalcaemia and impaired bone growth. This study also investigated the prevalence of vitamin D deficiency among Omani women and its relationship to sun exposure, food intake and type of clothing.

## Methods

Forty-one apparently healthy women aged 18–45 years with (mean ± standard deviation (SD), 29 ± 6 years), working in various departments of the Royal Hospital, Muscat, Oman, volunteered for this study. Exclusion criteria included known hepatic, renal or gastrointestinal disease, pregnancy, lactation and medication influencing bone metabolism such as calcium or vitamin D supplements. The study was approved by the Research Ethical Committee at the Royal Hospital. Informed consent was taken from all subjects who also were asked to complete a questionnaire before blood collection. The study was conducted in December 2006 (winter-autumn in Oman) where the temperature ranges from 15 to 28 °C.

All subjects completed a questionnaire on medical history, exposure to sunlight (estimated in minutes per week), skin type, sunscreen usage and type of clothing (i.e. exposure of hands and face). The questionnaire also estimated their dietary calcium and vitamin D intake, covering the commonest food preparations consumed by Omanis. Data on frequency of consumption (daily, weekly, monthly) as well as quantities consumed were collected and analysed.

The relation of vitamin D levels, sun exposure, dietary intake and application of sun screen were assessed. The sun exposure was calculated from the questionnaire and expressed in minutes per week. The dietary intake was also calculated using different parameters. In the questionnaire, the frequency of food consumption was quantified per day, per week and per month. The amount of food, weight of the product, vitamin content in the product, total vitamin D intake in that product and finally the total vitamin D consumed were also calculated. Then, vitamin D amounts per product were calculated from different sources (UK tables, Danish tables, and product ingredient information and the subjects' estimations for home cooked food).

Blood specimens were collected in Greiner Vacuette tubes (Greiner Bio-One GmbH, Baden-Württemberg, Germany) from each subject for the

**Table 1:** Biochemical bone markers in the study group  
(N = 41)

Biochemical markers	Mean ± SD	Median (Range)	Normal Range
Total calcium (mmol/L)	2.31 ± 0.07	2.31 (2.18–2.43)	2.1–2.6
Phosphate (mmol/L)	1.23 ± 0.12	1.26 (0.92–1.57)	0.7–1.4
ALP (IU/L)	51.59 ± 13.63	48 (30–98)	30–125
PTH (pmol/L)	3.81 ± 2.06	3.6 (1.4–11.7)	1.6–9.3
25(OH)D (nmol/L)	27.61 ± 5.35	28 (19–37)	75–250

Legend: ALP = alkaline phosphatase; PTH = parathyroid hormone; 25(OH)D = serum 25-hydroxyvitamin D.

measurement of the following analytes: serum total calcium, phosphate, albumin, alkaline phosphatase (ALP), parathyroid hormone (PTH) and 25(OH)D. For PTH analysis, serum samples were separated within 30 minutes following blood collection and kept frozen until analysis. Serum total calcium, phosphate, ALP and albumin were measured by Synchron LX20 PRO (Beckman Coulter, Inc., CA, USA); PTH was measured by Access 2 immunoassay (Beckman Coulter, Inc., CA, USA) at the Clinical Biochemistry Laboratory in the Royal Hospital. Frozen samples unprotected from light<sup>14,15</sup> were sent to Melbourne Pathology, Australia for the measurements of 25(OH)D using the LIAISON assay (DiaSorin, Inc., Minnesota, USA). This is a direct competitive chemiluminescent immunoassay for the quantitative measurement of total 25(OH)D. Using Biostat software, Spearman's rank correlation coefficient was calculated for the correlation between serum 25(OH)D levels; sun exposure and dietary intake.<sup>16</sup>

## Results

This study investigated vitamin D levels among childbearing Omani women and the prevalence of vitamin D deficiency and its relationship to sun exposure, food intake and type of clothing. The mean ± SD of age was 29 ± 6 years, 25(OH)D levels were 25 ± 6 nmol/L, vitamin D intake was 9 ± 4 ug/d and sun exposure was 70 ± 60 min/week. In all the subjects (100%), vitamin D levels were <50 nmol/L. The mean serum concentration of 25(OH)D in the

subjects was 25nmol/L (results ranged from 12 to 37 nmol/L) In 20 women (49%), 25(OH)D levels were ≥25 nmol/L. In the remaining 21 women (51%) the level was <25 nmol/L. All subjects had vitamin D deficiency which varied from mild, to moderate and even severe deficiency using the recommended cut off <50 nmol/L as a low 25(OH)D.<sup>17,18,19</sup>

All except one subject had serum PTH, serum calcium and phosphate within the reference interval. No significant correlation between serum 25(OH)D levels and calcium levels or serum phosphate level was noted in the subjects investigated. The results of different biochemical bone markers are presented in Table 1.

The most significant correlation of the 25(OH)D level was with sun exposure, as all the subjects covered their whole body except the face and hands ( $r = 0.672$ ,  $P < 0.001$ ) compared to the correlation with food intake ( $r = 0.482$ ,  $P < 0.01$ ). The correlation between 25(OH)D and age was weak and not statistically significant ( $r = 0.211$ ,  $P > 0.05$ ). Sun screen was used by 15 subjects (36%) and was only applied on the face and not on regular basis and no correlation was found between application of sun screen and 25(OH)D levels ( $r = -0.02$ ,  $P > 0.05$ ).

As sun exposure had the strongest correlation, two cut offs were defined for sun exposure time to assess the relation between 25(OH)D and sun exposure time [Table 2]. With sun exposure at <60 min/week, the mean 25(OH)D and PTH were 27 nmol/L and 4.14 pmol/L respectively, while with sun exposure ≥ 60 min/week, the mean 25(OH)D and PTH were 29.5 nmol/L and 2.92 pmol/L respectively. The mean of serum calcium and phosphate was comparable in both subgroups [Table 3].

## Discussion

This study reveals that 25(OH)D deficiency is likely to be very common among Omani adult women given the prevalence of 100% in the studied group. This may seem an unexpected result as Oman is one of the sunniest countries in the world where people would be expected to have adequate sun exposure. Although vitamin D deficiency is defined as serum 25(OH)D level <50nmol/L,<sup>17,20</sup> an epidemiological survey-based recommended cut-off, this may not necessarily reflect the desirable level among Omani

Table 2. Biochemical bone markers according to sun exposure

Biochemical bone markers	Sun exposure				P value
	≥60 min/week		<60min/week		
	Mean±SD	Median (range)	Mean	Median (range)	
Total calcium (mmol/L)	2.32 ± 0.007	2.33 (2.19–2.42)	2.30 ± 0.06	2.30 (2.18–2.43)	<0.01
Phosphate (mmol/L)	1.20 ± 0.10	1.23 (1.01–1.31)	1.25 ± 0.13	1.26 (0.92–1.57)	<0.01
ALP (IU/L)	39.18 ± 9.11	48 (38–69)	52.47 ± 14.99	47.5 (30–98)	<0.01
PTH (pmol/L)	2.92 ± 1.05	2.60 (1.7–4.8)	4.14 ± 2.25	3.7 (1.4–11.7)	<0.01
25(OH)D (nmol/L)	28.7 ± 5.33	29.50 (20–37)	27 ± 5.41	27.50 (19–36)	<0.01

Legend: ALP = alkaline phosphatase; PTH = parathyroid hormone; 25(OH)D = serum 25-hydroxyvitamin D.

women.

The low vitamin D level may be due to several factors including direct and indirect avoidance of sunlight exposure due to cultural and social reasons (concern about appearance, unwillingness to change skin colour, the burning effect of the sun, and the risk of hot weather related sickness). Most of the women included in the study were working full-time so they were indoors for most of the day-time and, like the majority of Omanis, they anyway prefer only to be outdoors after sunset. Most of the women included in the study were asymptomatic; they did not suffer from bone pain, myalgia or tiredness and their biochemical markers were within the normal range.

It appears that the way people dress is not the only reason for the low vitamin D status. Islam et al. for example, showed that woman in Bangladesh, regardless of their lifestyle and clothing, were at risk of developing vitamin D deficiency and that both veiled and unveiled women can have vitamin D deficiency.<sup>11</sup>

In this study, many women were aware about the need for a healthy diet containing high calcium intake and some were also aware of the importance of vitamin D for health. Hence, they were trying to compensate for this demand by having adequate calcium and vitamin D intake either by increasing the intake of fish and egg or using fortified food like margarine and milk which they know to be rich in these constituents. However, although in the study the adequate vitamin D intake was defined to be 5ug/day (200 IU/day) for those aged <50 year,<sup>17,20</sup> surprisingly only 6 subjects (15%) had less than 5ug/day. The discrepancy may be due to coexisting vitamin D deficiency, malabsorption,

overestimation of vitamin D content in the food consumed, (when using the UK and Danish tables), lack of information on labels of fortified food and wrong estimations for home cooked foods. The latter could have led to inter-individual variations in estimating vitamin D content for home cooked food. Hence, there is a concern about the subjects' reliability and accuracy in estimating their food intake.

Although a significant correlation was observed between 25(OH)D and sun exposure, none of the subjects had enough sun exposure. The amount vitamin D produced by the human skin is proportional to the surface area of skin exposure to sunlight. All the subjects were known to be covered (except the face and hands), but at least 15–20% of body surface needs to be exposed to sun to provide the minimal erythemal dose of ultraviolet light that is sufficient for the first step in vitamin D synthesis (conversion of cholcalciferol from its precursors).<sup>17</sup>

The amount of sunlight exposure that is needed also varies depending on skin type, time of day, altitude and season. Since, for religious and cultural reasons, it is hard for Omani women to increase the body surface area that is exposed to sun, they have to increase the time of exposure to sunlight or/and to take vitamin D supplements to avoid the consequences associated with vitamin D deficiency. Special consideration is required for pregnant and lactating women in order avoid the perinatal and post-natal complications associated with low maternal vitamin D.

## Conclusion

A high prevalence of subclinical vitamin D

**Table 3. Biochemical bone markers according to 25 (OH) D levels. Data are presented as mean ± standard deviation (median)**

Biochemical bone markers	25(OH)D		P value
	<25 nmol/L	≥ 25 nmol/L	
Total calcium (mmol/L)	2.31 ± 0.06 (2.30)	2.31 ± 0.06 (2.32)	<0.01
Phosphate (mmol/L)	1.22 ± 0.11 (1.22)	1.24 ± 0.15 (1.28) (0.92–1.57)	<0.01
ALP (IU/L)	48.2 ± 12.75 (45)	54.15 ± 12.73 (51)	<0.01
PTH (pmol/L)	4.38 ± 2.52 (4.30)	3.68 ± 1.83 (3.10)	<0.01
25(OH)D (nmol/L)	19.47 ± 1.77 (19)	30.35 ± 3.48 (30)	<0.01

Legend: ALP= alkaline phosphatase; PTH= parathyroid hormone.

deficiency amongst Omani females of childbearing age has been observed in this population. Sunlight is major contributor to 25(OH)D levels, but their exposure still appears to be insufficient. If the subjects can not improve their sunlight exposure, they should take oral vitamin D supplements. Further studies may be recommended to determine the incidence of osteomalacia and osteoporosis in the Omani population and assess vitamin D status in patients with chronic diseases.

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#### CONFLICT OF INTEREST

The author reported no conflict of interest.

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