Vitamin D status and its associated factors of free living Malay adults in a tropical country, Malaysia

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Abstract

Vitamin D status is influenced by sun exposure, geographic latitude, daily outdoor activities, body surface exposed to sunlight and dietary intakes. Malaysia, is sunny all year round. However, the vitamin D status of this population especially among the healthy and free living adults is not known. Therefore a study of vitamin D status and associated factors was initiated among an existing Malay cohort in Kuala Lumpur. A total of 380 subjects were sampled to have their vitamin D status assessed using 25-hydroxyvitamin D (25(OH)D). A short questionnaire enquiring socio-demographic characteristics, exposure to sunlight and clothing style was administered. Their mean age was 48.5 ± 5.2 years and the mean 25(OH)D for males and females were 56.2 ± 18.9 nmol/L and 36.2 ± 13.4 nmol/L respectively. There were significant positive correlation for sun exposure score (r = 0.27, p < 0.001) and negative correlation for sun protection score (r = −0.41, p < 0.001) with 25(OH)D levels. In the logistic regression model, females (OR = 2.93; 95% CI: 1.17, 7.31), BMI (1.1; 1.03, 1.20) and sun exposure score (0.998; 0.996, 0.999) were significantly associated with vitamin D status as represented by 25(OH)D levels. Our findings show that obesity, lifestyle behaviours and clothing style are directly associated with our participants especially females’ low vitamin D status.

1. Introduction

Vitamin D is well known for its role in bone health and recent work has suggested its role in diabetes and cardiovascular diseases. Systematic reviews [1–3] suggested a possible inverse association between Vitamin D and cardiovascular risks. In meta-analysis by Parkera et al. [4], individuals with the highest levels of serum vitamin D were associated with a 43% reduction in cardiometabolic disorders (OR 0.57, 95% CI: 0.48–0.68).

Vitamin D adequacy is evaluated by measuring serum 25-hydroxyvitamin D, 25(OH)D concentration, as this is the primary circulating form of vitamin D. This serum concentration of 25(OH)D is a good reflection of cumulative exposure to sunlight and dietary intake of vitamin D, and is widely regarded as a robust "gold standard" indicator of vitamin D status [5].

Vitamin D is synthesized in the skin after sunlight exposure or can be obtained through a balanced dietary intake or vitamin D supplement. However, it is well known that natural sources of vitamin D in foods are not sufficient to supply the body requirements. Therefore, skin synthesis of vitamin D through exposure to sunlight is thought to constitute the major source of vitamin D [6]. Consequently, vitamin D status is thought to be influenced by seasons, geographic latitude, daily outdoor activities, and the percentage of body surface exposed to sunlight [7]. This significant role of sunlight in vitamin D synthesis suggests a low prevalence of vitamin D deficiency in tropical countries. However, studies carried out in Hawaii, Turkey, India, Iran and Saudi Arabia have shown a high prevalence of vitamin D deficiency [8–12].

Malaysia is a tropical country located at the Equator and is sunny all year round. However, the vitamin D status of the population especially among the healthy and free living adults is not known. There are also no particular public health programs that focus on the vitamin D status of the population. Furthermore, recent evidences show possible associations of vitamin D status with diabetes, cardiovascular diseases and cancers in the long term. This may increase the incidence of these chronic diseases in the future. We set out to study the vitamin D status of a Malay cohort in Kuala Lumpur and to demonstrate what are the factors associated with vitamin D status.

2. Materials and methods

2.1. Study population

This was an analytical cross-sectional study. The study population was a group of Malay employees from a health screening program of a public university in Kuala Lumpur. Malays constituted...
about 65% of the country's population and they are Muslims by religion. They are also the largest ethnic group (more than 70%) that work in the university. Due to limited research budget, a convenient sample of 380 eligible Malay employees was invited to take part in the study. All participants were aged 35 years and above as this screening program only included staff of this age range. Approval was obtained from the Medical Ethics Committee of the medical centre (Reference Number: MEC 782.218) and the management of the university. Written informed consent was given by all participants.

2.2. Data collection

Data was collected in May–July 2010 in the university campus. Vitamin D status of the participants was assessed using venous blood. The biochemical test used was the LAISON(R) 25 OH Vitamin D TOTAL Assay. This assay used chemiluminescent immunoassay (CLIA) technology for the quantitative determination of 25(OH)D. The LAISON 25 (OH) D Total assay measures between 1.0 and 375 nmol/L. The inter-assay precision approximates 20% CV (functional sensitivity). These biochemical analyses were outsourced to a private laboratory with international quality control Certificate of Accreditation (MS ISO 15189). Serum 25(OH)D of less than 50 nmol/L was classified as vitamin D insufficiency [7] in our study. A short questionnaire enquiring socio-demographic characteristics, medical history of diabetes mellitus and hypertension (self-reported), exposure to direct sunlight (duration in minutes per day in a week) and clothing style (such as wearing long sleeves, long skirt/pants, veils, hat/cap, sun block lotion, use of umbrella) was self-administered by the participants. Sun protection score was derived through the sum of usage of sun block lotion, veil, cap/hat, long sleeve shirt, gloves, long pants, long skirts and umbrella (max = 8, min = 0); while the sun exposure score was derived by multiplying the duration in minutes of sun exposure per day with number of days per week.

Anthropometric measurements such as weight, height and waist circumference were also measured. Weight and height were measured using calibrated digital weighing scales and stadiometers respectively. The waist and hip circumferences were measured with circumference measurement tape. The waist was defined as the point midway between the iliac crest and the costal margin (lower rib); while the hip circumference was defined as being the widest circumference over the buttocks and below the iliac crest [13,14]. All measurements were conducted by trained staff and regular meetings were conducted to ensure standard protocols were used for all measurements. Body Mass Index (BMI) was derived following the formula of weight in kg/height^2 in meters. The Asian BMI [15] cut off with overweight being defined as BMI of 23.0–26.9 kg m^2 and obese as ≥27 kg m^2 was used.

Table 1

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n (%)</th>
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</thead>
<tbody>
<tr>
<td>Sex:</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>158 (41.6)</td>
</tr>
<tr>
<td>Female</td>
<td>222 (58.4)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
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<td></td>
<td>41 (10.8)</td>
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<tr>
<td>Hypertension</td>
<td>95 (25.0)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>37 (9.7)</td>
</tr>
<tr>
<td>BMI (kg/m²):</td>
<td></td>
</tr>
<tr>
<td>Normal weight (18.5–22.9)</td>
<td>60 (15.8)</td>
</tr>
<tr>
<td>Overweight (23.0 – 26.9)</td>
<td>127 (33.4)</td>
</tr>
<tr>
<td>Obese (≥27.0)</td>
<td>193 (50.8)</td>
</tr>
<tr>
<td>Age (mean ± SD) years</td>
<td>48.5 ± 5.2</td>
</tr>
<tr>
<td>Vitamin D status : sufficient</td>
<td>122 (32.1)</td>
</tr>
<tr>
<td>Insufficient</td>
<td>258 (67.9)</td>
</tr>
</tbody>
</table>

2.3. Data analysis

Data was entered and analysed using SPSS for Windows version 16.0. Categorical variables were presented as frequency and percentages while quantitative variables were presented as mean ± standard deviation (SD) where appropriate. Independent t test, Chi square test and correlation were used in univariate analysis. Multivariate analysis using Logistic regression was conducted. Significant factors associated with vitamin D status were entered into the logistic regression model to adjust for confounding and area under the Receiver Operating Curve (ROC) was also calculated.

3. Results

A total of 380 Malay employees participated in this study, 222 (58.4%) were females. Their mean age was 48.5 ± 5.2 years (Table 1). About 25% of them were hypertensive and 11% were diabetics. Only one third of the participants had sufficient level of 25(OH)D (≥50 nmol/L). More than 80% of participants were overweight or obese. Fig. 1 shows the distribution of serum 25(OH)D for both females and males. There were significantly more females with serum 25(OH)D of less than 50 nmol/L as compared to males. The mean 25(OH)D for males and females were 56.2 ± 18.9 nmol/L and 36.2 ± 13.4 nmol/L respectively.

Fig. 2 shows the clothing style and sun protection use by gender. Females were found to have most parts of their body covered. There were significantly more males (73.6%) reported to be exposed to the sun directly and about half of them were exposed directly to sunlight via work (p < 0.05) compared to females. Among the females, their mean sun exposure score was significantly lower (p < 0.001) and sun protection score was significantly higher (p < 0.001) compared to males. Serum 25(OH)D levels was also found to be significantly lower among the females (p < 0.001) (Table 2).

Sun exposure score was positively correlated with 25(OH)D levels (r = 0.27, p < 0.001) while sun protection score was negatively correlated (r = -0.41, p < 0.001) with 25(OH)D levels as shown in Figs. 3 and 4.

Table 3 shows the logistic regression model with all factors after adjusted for gender, BMI, age, sun protection score and sun exposure score. Females were 2.9 times more likely to have insufficient 25(OH)D levels. Participants who were obese had slightly higher odds of being 25(OH)D insufficient while age and sun exposure score were protective of 25(OH)D insufficiency. Sun protection score which reflected the clothing style became marginally insignificant after adjusted for all the above confounders. The area under the ROC for the logistic model was 0.84 (95% CI: 0.79, 0.89).

4. Discussion

There was a high proportion of participants having insufficient 25(OH)D level (<50 nmol/L), particularly the females. Their mean levels of 25(OH)D of 36.2 ± 13.4 nmol/L may not only increase their risks in cardiovascular diseases but may also predispose them to osteomalacia or rickets in the future. Immediate action such as prescribing vitamin D supplements needs to be taken to correct this situation.

There are few reports on vitamin D status in Malaysia. One published study reported the vitamin D levels of post-menopausal women [16] and another studied on women of child bearing age [17]. The postmenopausal Malay women [16] were reported to have 25(OH)D level of 44.4 ± 10.6 nmol/L which was higher than our female participants. Green et al. [17] reported over 60% of women in Kuala Lumpur had 25(OH)D levels below 50 nmol/L. There was no
published finding on men. Our female participants had significantly lower mean 25(OH)D levels than males. This could largely be explained by their clothing style (wearing long sleeves, long skirts, and veil), use of umbrella, avoiding the sun, working indoors etc. Similar findings are reported elsewhere [8,9,12]. The positive correlation of sun exposure score and the negative correlation of sun protection score with 25(OH)D levels demonstrate that sunlight probably is the main source of 25(OH)D among this sample.

Our study found obese participants were more prone to have low 25(OH)D levels, similar as other studies [18–21]. This may be explained by the hypothesis that 25(OH)D which is fat soluble, is sequestered in the large adipose compartment and low in serum among obese individuals [20,22].

Age was found to be negatively associated with 25(OH)D levels, where older participants had higher 25(OH)D levels. Our results contradict existing evidence where older individuals are more susceptible for low 25(OH)D levels [12]. The reason for this contradicting result is not clear. There was also no significant association in the sun exposure or sun protection score among various age groups (results not shown).

This study shows that gender (female), BMI, sun protection behaviour especially clothing style and sun exposure are important

Table 2
Sun exposure, sun protection and 25 (OH) D levels of participants by gender.

<table>
<thead>
<tr>
<th></th>
<th>Male (n = 91)</th>
<th>Female (n = 135)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed to sun directly</td>
<td>67 (73.6)</td>
<td>75 (55.6)</td>
<td>0.006</td>
</tr>
<tr>
<td>Work</td>
<td>49 (53.8)</td>
<td>45 (33.3)</td>
<td>0.002</td>
</tr>
<tr>
<td>Exercise</td>
<td>41 (45.1)</td>
<td>52 (38.5)</td>
<td>0.262</td>
</tr>
<tr>
<td>Sun exposure score (mean ± SD)</td>
<td>329.8 ± 54.3</td>
<td>93.1 ± 14.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sun protection score (mean ± SD)</td>
<td>1.7 ± 0.7</td>
<td>3.2 ± 0.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>25 (OH) D (mean ± SD) (nmol/L)</td>
<td>56.2 ± 18.9</td>
<td>36.2 ± 13.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

SD: standard deviation.
* Days per week × duration (min).
** Sum of usage of sun block lotion, veil, cap/hat, long sleeve shirt, gloves, long pants, long skirts and umbrella (max = 8, min = 0).

Fig. 3. Association of sun exposure score with serum 25(OH)D.

Fig. 4. Association of sun protection score with serum 25(OH)D.
Factors influencing vitamin D status (as reflected by the levels of 25(OH)D) among the Malays. However, there should be caution in generalising these results to the population as our Malay participants only represent staff working in an urban public university. This result may not be generalisable to Malays in the rural area who work in the agriculture sector. Our study also did not assess dietary intake of vitamin D rich food. However, the high AUC obtained from our logistic model showed that factors studied in this study were able to predict more than 80% of vitamin D status of this population. In addition, this study is probably one of the few studies that assessed vitamin D status of free living healthy adults (men and women) in the country. This will serve as a pilot study for more extensive and comprehensive research among all races of the country.

Although Malaysia is a country with plenty of sunlight all year round, our findings show majority of our participants who are of Malay ethnicity have low vitamin D status. This has given rise to concerns that sun protection could adversely affect vitamin D status and health. Urgent measures are needed to prevent long term complications related to bone health, cardiovascular diseases and cancers. These measures should include the assessment of vitamin D status among the population, more particularly in women who adopt concealing clothing, decreasing cutaneous surface available for a sufficient sunlight exposure. It may also be important to fortify milk, dairy products, or other food and beverages in order to assure a sufficient vitamin D intake among the population. Until these general measures become effective, more research is needed to evaluate the clinical impact of the above findings.

In summary, our Malay cohort especially females had low vitamin D status. The clothing style, working indoors and avoiding exposure to sunlight explain the low vitamin D status among females. Other factors associated with vitamin D status are age and BMI. More extensive and comprehensive research among all races of the country is urgently required to evaluate their vitamin D status as well as its clinical impact.

Acknowledgements

This work was supported by research Grants from the University of Malaya. We would like to express our sincere appreciation to all participants and staff that assisted in this study.

### Table 3

<table>
<thead>
<tr>
<th>Factors</th>
<th>Crude OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>9.52 (5.76, 15.74)</td>
<td>2.93 (1.18, 7.31)</td>
</tr>
<tr>
<td>BMI</td>
<td>1.12 (1.07, 1.19)</td>
<td>1.11 (1.03, 1.20)</td>
</tr>
<tr>
<td>Age</td>
<td>0.92 (0.88, 0.96)</td>
<td>0.92 (0.86, 0.99)</td>
</tr>
<tr>
<td>Sun protection score</td>
<td>2.45 (1.76, 3.39)</td>
<td>1.52 (0.98, 2.36)</td>
</tr>
<tr>
<td>Sun exposure score</td>
<td>0.997 (0.996, 0.998)</td>
<td>0.998 (0.996, 0.999)</td>
</tr>
</tbody>
</table>

AUC = 0.84 (95% CI:0.79, 0.89); p < 0.001.

AUC: area under curve.

OR: odds ratio.

References


