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Sunlight Exposure Increases Vitamin D Status of Young Adult Emirati Females with Hypovitaminosis

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ABSTRACT

Vitamin D deficiency is widely common among nationals of the Arabic Gulf region despite the abundance of sunshine throughout the year. We investigated in a pilot study whether advised sun exposure for 12 weeks could improve the vitamin D status of young adult Emirati females. A convenience sample of Emirati females (N=114) attending a federal university in Abu Dhabi were invited to participate in the study. After assessment of vitamin D status, a total of ten females with hypovitaminosis were randomly selected as sunlight exposure intervention group. Participants in the intervention group agreed to expose the face, arms and hands for a total of 60 minutes per week without the use of sunscreen. All sunlight exposure sessions were done privately and recorded in a diary for documentation by the participant herself. A natural none-intervention control group of participants (N=10) who did not seek any treatment despite the advise was considered for comparison. Serum concentrations of 25-hydroxy vitamin D (25OHD), anthropometric and lifestyle variables related to sun exposure were all measured in each participant at baseline and after 12 weeks. Results demonstrated that mean serum 25(OH)D concentrations for the intervention group increased from 10.50 ± 5.37 ng/mL at baseline to 19.52 ± 11.67 ng/mL after 12 weeks. The increase was statistically significant as revealed by the t-test $t [18] = 2.61$, $p < 0.05$ (Cohen's $d = 1.23$). On the other hand, the mean serum 25(OH)D concentrations for the natural control group dropped slightly after 12 weeks from 10.92 ± 6.23 ng/mL to 9.02 ± 4.97 ng/mL. Even though there was no statistical difference in the sun avoidance index between the 2 groups (difference = -2.1; SE ± 6.4 $P = 0.74$), however, some extra sun exposure resulted in statistically and clinically important differences in the vitamin D concentration between the groups ($P = 0.01$). This study showed that sunlight exposure could be a simple but effective way to improve vitamin D status among female Emiratis who minimize sun exposure to the skin due to heat and both cultural and religious reasons. Further investigations should include a group of participants with supplements and increase the sample size.

Keywords: Vitamin D deficiency, Sunlight exposure, Emirati females, United Arab Emirates.

INTRODUCTION

Vitamin D has recently become a focus of attention for several researchers not only because of its importance for bone turnover and integrity^{1,2} but because of its association with reduced risk against several chronic morbidities such as diabetes, cardiovascular diseases, multiple sclerosis and many types of cancer^{3,4}. Hypovitaminosis has become a global public health burden that has serious consequences among individuals from all age groups. Inadequate skin exposure to sunlight and low dietary intake of

vitamin D have been the main factors for the vast emergence of hypovitaminosis and vitamin D deficiency^{1,3}.

Maintaining an adequate vitamin D status requires direct exposure of skin to sunlight but can also be secured through the consumption of foods that are either naturally rich or enriched with vitamin D and high dose vitamin D supplementation when sunlight exposure is minimal⁴. Several factors affect the natural means of vitamin D production through sunlight exposure depending on the amount of ultraviolet B rays which are available. Such factors include latitude, season, skin melanin content and pigmentation, the amount of skin exposed to sunlight and the duration of sun exposure^{1,4,5}. In addition, age, obesity and fat malabsorption conditions like celiac and Crohn's disease are all associated with lowered vitamin D status^{1,4,5}.

Populations of Arabic countries like the United Arab Emirates (UAE) are at greater risk than others for developing vitamin D deficiency because of certain risk factors including skin pigmentation, deliberate avoidance of sunlight exposure due to heat and the dress style which covers most of the body⁶. There are relatively few studies exploring vitamin D and its health implications within the UAE. Despite the availability of sunshine in the UAE, vitamin D deficiency is common among Arab mothers and infants residing in the UAE^{6,8}. Moreover, osteoporotic Emirati women suffer from mild to severe vitamin D deficiency⁸. A more recent study has demonstrated the high prevalence of vitamin D deficiency among young adult Emiratis⁹ and adult UAE residents who work indoors due to their sun avoidance behaviors¹⁰. It has been suggested that outdoors direct sunlight skin exposure of the face, arms and hands for 5–10 minutes 2 or 3 times a week combined with vitamin D supplements is required to ensure vitamin D sufficiency^{5,11}. This recommendation had been based on studies conducted among Caucasians in North America and Europe but had not been replicated in Arab women despite the reported high prevalence of vitamin D deficiency. This preliminary study aimed at exploring the potential use of increased sunlight exposure as a strategy to improve vitamin D status among young adult Emirati females.

METHODS

Study Design and Setting

The study was designed as a randomized controlled trial of 12 weeks duration to investigate the efficacy of increased sunlight exposure as an intervention for hypovitaminosis among young adult Emirati females. It was conducted between January and March 2013 in Abu Dhabi (the capital city of the UAE) which is located at latitude 24° N, longitude of 55° E and has an average of 8-10 hours of sunshine per day during the study period months. Data and blood samples were collected at baseline and 12 weeks after intervention. The study was approved by the research ethics committee at Zayed University and written informed consent was obtained from participants who were eligible and willing to be enrolled in the study.

Participants

A convenience sample of Emirati females attending a federal university in Abu Dhabi were recruited voluntarily to participate in the study by invitation through electronic campus announcement. For the purpose of the study, a website entitled Sunshine Arabia was developed as a prescreening tool to assess vitamin D status in the context of sunlight exposure by using the sun avoidance inventory (SAI) which assigns a score for attitude and behavior towards sunlight exposure^{9,10,13,14}. Participants with high SAI scores were deemed eligible to enroll in the study because they were avoiding sunlight exposure the most. All those who were taking vitamin D supplementation or who suffered from disorders such as chronic or severe liver disease, renal disease or malabsorption were excluded the study.

Randomization and Intervention

The study was conducted over two phases. In the first phase of the study, a total of 114 respondents were tested for vitamin D levels and informed of their blood test results in writing after three days. They were all urged to further discuss results with a specialized physician. They were also provided with the detailed cutoff limits which define vitamin D sufficiency, insufficiency and deficiency. For the second phase of the study, a list of eligible participants who were willing to continue in the study was later generated. Eligibility entailed a low vitamin D level with serum 25 (OH)D less than 25 nmol/L and high SAI with a

score of 45 and above. A total of ten females were then randomly selected and assigned to sunlight intervention group.

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Participants in the intervention group (N= 10) agreed to expose the face, arms and hands for 30 minutes between 10.00 a.m. and 2.00 p.m. for 2 days in the week without the use of sunscreen and had to keep a diary as a record of sunlight exposure for the entire study period. All sunlight exposure sessions were done privately either within each participant's house courtyard or clubs specialized for women in order to consider religious and cultural norms. Moreover, to assess adherence to advised sun exposure, participants in this group were met weekly and interviewed about their attitudes towards sunlight exposure with regards to their self reported information in their diaries. To limit changes in vitamin D status due to diet, all participants were asked to maintain their usual dietary habits for the entire 12 weeks of the study. The rationale behind selecting only ten subjects for intervention was based on the fact that the study was pilot and follow up/interview sessions with the participants to ensure compliance could reasonably accommodate ten individuals.

All other participants were provided with brochures about vitamin D deficiency and how to treat it. They were also alerted to the serious consequences of vitamin D deficiency and urged to seek medical attention. However, most of them did not seek medical attention nor attempt to boost their vitamin D levels as per recommendations via sunlight exposure, supplements or specialized diet. This somehow created a natural none-intervention control group of participants who did not seek any treatment despite the advise. From these participants, ten were randomly selected after 12 weeks to match as controls for the individuals in the intervention group. This enabled us to avoid any ethical issues associated with a placebo-control group.

Outcome measurements and data collection

Serum 25(OH)D concentrations, the most widely used assessment of body vitamin D status, was measured in each participant at baseline and 12 weeks after intervention. Serum 25(OH)D was measured by Diasorin (LIAISON) and high performance liquid chromatography (HPLC) according to previous methods. The intra-assay coefficient of variation was 4% and the inter-assay coefficient of variation was 5.8%⁹. The reference range for vitamin D was adopted from Grant et al. (2010); Sabetta et al. (2010) and included deficiency, insufficiency, and sufficiency (<10, 10.4 to 30, and >30 ng/ml), respectively^{4,12}.

Potential confounders like body mass index (BMI), time of sunshine exposure and duration were all recorded. Height was measured in centimeters (cm) using a SECA stadiometer with the participant standing in an upright position without shoes. Body weight was measured to the nearest 0.2 kilograms (kg) using a digital scale without heavy clothing. Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters square. BMI was categorized into three groups: underweight (BMI<20 kg/m²), normal weight (20 kg/m²≤BMI<25 kg/m²), and overweight (BMI≥25 kg/m²). Information on sunlight exposure was based on self-report. To estimate the daily sunlight exposure, the respondents were asked to indicate time of day and minutes spent outdoors. Sun exposure was evaluated by using SAI, which is a questionnaire designed to assess attitude towards sun avoidance^{9,10,13,14} and the recorded minutes of sunlight exposure per week. The SAI uses a five point Likert scale to record participant's responses, from strongly agree, to strongly disagree, graded 0 to 4 depending on the item direction. A high overall score on the SAI (49 and above) indicates that the individual minimizes sun exposure, while a low score reveals that the individual maximizes exposure to sun^{13,14}.

Data analysis

All statistical analyses were conducted by using SPSS version 21.0 (Chicago, IL). Means and standard deviations were used to describe vitamin D status. The p values were calculated by using SPSS for categorical variables and linear regression for continuous variables. Differences in 25(OH)D concentrations and other measures were analyzed with Lavene's test. Comparisons of serum 25(OH)D concentrations were performed by using the Student t test and p values less than 0.05 were considered to be statistically significant.

RESULTS

The mean age of participants in the first phase of the study was 20.83 ± 3.98 with no differences in age between the intervention (21.00 ± 1.32) and control group (21.00 ± 1.06).

A total of 60 participants out of 114 in the first phase had serum 25(OH)D less than 20 nmol/L. Table 1 shows the baseline characteristics of participants according to several outcomes and reflects the absence of differences between the two groups in terms of age, BMI, SAI and 25(OH)D prior to intervention. Participants in both groups were vitamin D deficient and had high SAI scores at baseline.

Adherence to increased sunlight exposure was generally high as evidenced by the recorded sunlight diaries and weekly interviews. Considering high adherence as reporting more than 60 % of the total 720 exposure minutes during the 12 week period, 8 out of the 10 subjects showed high adherence. The other two reported an average exposure of around 40 %.

Mean serum 25(OH) D concentrations for the intervention group increased from 10.50 ± 5.37 ng/mL at baseline to 19.52 ± 11.67 ng/mL after 12 weeks. The increase was statistically significant as revealed by the t-test $t[18]= 2.61$, $p < 0.05$ (Cohen's $d= 1.23$). On the other hand, the mean serum 25(OH)D concentrations for the natural control group dropped slightly after 12 weeks from 10.92 ± 6.23 ng/mL to 9.02 ± 4.97 ng/mL. Figure 1 shows the distribution of serum 25 (OH) D levels for participants in both groups at baseline and after 12 weeks.

Mean SAI scores for participants in both groups were similarly high at baseline (50.00 ± 7.20 and 50.70 ± 7.33 for the intervention and control group, respectively). After 12 weeks, the scores were lowered to 46.60 ± 9.64 for the intervention group but got even higher for the natural control group with a mean value of 54.40 ± 17.79 . Differences in SAI scores at baseline and 12 weeks were statistically significant for both the intervention and control groups. Figure 2 shows the distribution of SAI scores for participants in both groups at baseline and after 12 weeks.

Table 1. Baseline characteristics of Participants According to Outcome Measurements

<u>Variables</u>	<u>Sunlight intervention(n=10)</u>	<u>Natural Control (n=10)</u>	
Age (years)	21.00 ± 1.32	21.00 ± 1.06	
BMI(kg/m ²)	28.7 ± 6.2	28.5 ± 6.0	
SAI score	50.00 ± 7.20	46.60 ± 9.64	
25 (OH)D (ng/mL)	10.50 ± 5.37	10.92 ± 6.23	0.0025*

* Significant; $p < 0.05$. All values are shown as mean \pm SD

BMI: body mass index; SAI: sun avoidance inventory;

Fig.1: Distribution of Serum 25 (OH)D Levels for Participants at Baseline and After 12 Weeks

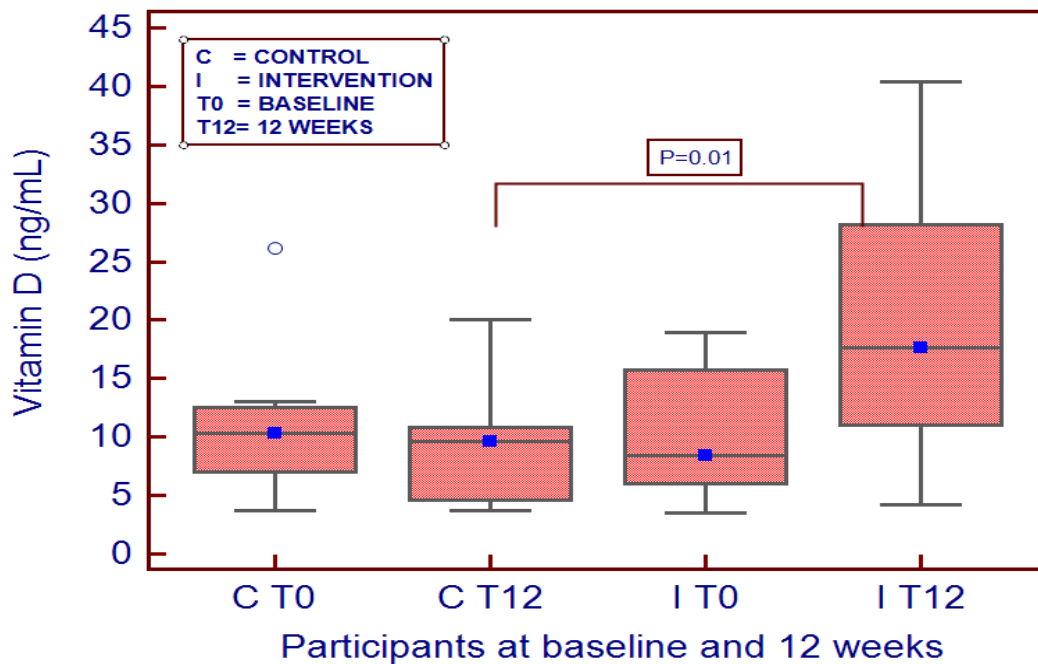
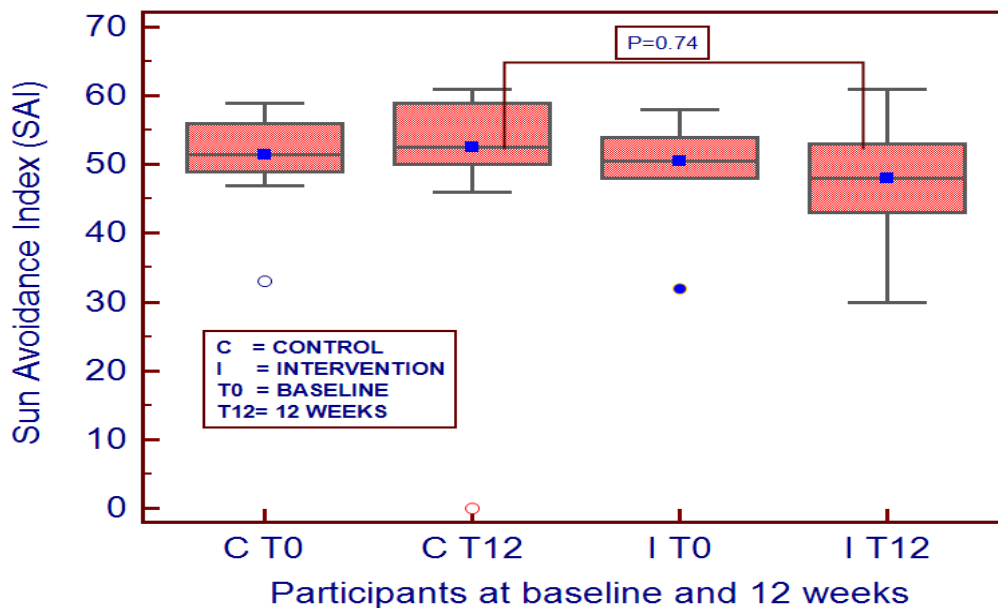


Fig.2: Distribution of SAI Scores for Participants at Baseline and After 12 Weeks



DISCUSSION

The objective of this study was to compare the impact of increased skin sun exposure on vitamin D status among young Emirati females with hypovitaminosis. The findings revealed that a modest but significant improvement in vitamin D status as measured by serum 25(OH)D concentrations could be achieved from 60 minutes of direct sunlight exposure per week of the face, forearms and hands. The fact that two of the ten participants from the sunlight intervention group became vitamin D sufficient and five transitioned from being deficient to insufficient after 12 weeks while all participants in the natural control group remained vitamin D deficient is promising and requires more investigation. The significant differences among participants in both groups in terms of serum 25(OH)D and SAI scores only post intervention after the end of 12 weeks highly suggests that the increased duration of sunlight exposure and changes in behavior towards favoring sunlight exposure by participants in the sunlight intervention group as compared to those in the natural none-intervention group have triggered an elevation in serum 25(OH)D

levels. Other factors which could contribute to changes in vitamin D status include BMI, age, dietary intake and season. Such variables did not have an effect in our study because of the absence of differences among participants in both groups in terms of age and BMI. Although the dietary intake of vitamin D was not assessed, it is unlikely to explain the increase in serum 25(OH)D concentrations post-intervention among the participants in the sunlight intervention group. Previous research indicated that the dietary vitamin D intake among this subpopulation was insufficient⁶⁻⁸. Our previous findings revealed that diet however did not affect vitamin D status significantly among this subpopulation⁹. Furthermore, the participants in this study agreed not to change their dietary habits during the study period and were not taking vitamin D supplementation. The increase in serum 25(OH)D concentration was unlikely to have been affected by the season of the study as the UAE has a sunny weather almost all year and average temperatures from January till March are comparable. To our knowledge, this is the first randomized controlled trial to assess the effect of extended sunlight exposure on vitamin D status specifically among young adult female Emiratis. Our results were in concordance with reported findings of another pilot study previously conducted on Arab women residing in the UAE¹⁵. Despite the low number of participants (N=8) and the short duration of four weeks for the study, valuable implications about the efficacy of sun exposure in treating hypovitaminosis were concluded. A major difference from our study was the absence of a control group and the shorter time of sunlight exposure (30 minutes per week). Another analogous study by Reid et al., investigated the efficacy of sunlight exposure among 15 elderly subjects in Auckland for 4 weeks after a daily exposure of either 15 or 30 minutes. The research demonstrated a corresponding rise in 25(OH)D levels by 7 and 18.5 nmol/l¹⁶.

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Some researchers have suggested vitamin D supplementation to improve vitamin D status¹⁷, while others have tried to promote for safe skin sun exposure³ as a natural alternative. A randomized clinical trial among nonwestern adult immigrants (N=232) residing in the Netherlands investigated the impact of increased sunlight exposure versus vitamin D supplementation. Participants were similar to the ones in our study in the sense that they all had hypovitaminosis and practiced similar sun exposure behavior because they wore clothing that covered the whole body except for the face and hands. The study demonstrated that daily 800 IU or 100,000 IU/3 months were more effective than advised sunlight exposure for treating vitamin D deficiency among this community¹⁸. The low adherence to the sunlight sessions as compared to the high adherence in our study makes it difficult however to compare results. Another study on 602 elderly participants from old care facilities within Sydney demonstrated that sunlight exposure was not effective as compared to vitamin D supplementation due to poor adherence to the advised intervention¹⁹. On the other hand, a study by Chel and colleagues had shown that ultraviolet irradiation is as effective as vitamin D supplementation in geriatric patients²⁰.

In conclusion our study demonstrated that it could be feasible to improve vitamin D status with an apparently simple and widely applicable public health measure, namely increased sun exposure. The study findings highlight that increasing sunlight exposure could be utilized to maintain healthy vitamin D status for individuals in a country like the UAE famous for its sunny weather throughout the year but are highly at risk of developing .

In conclusion our study demonstrated that it could be feasible to improve vitamin D status with an apparently simple and widely applicable public health measure, namely increased sun exposure. The study findings highlight that increasing sunlight exposure could be utilized to maintain healthy vitamin D status for individuals in a country like the UAE famous for its sunny weather throughout the year but are highly at risk of developing . This study has a number of strengths and weaknesses. Methodological restrictions included the absence of a placebo-control group and supplementation group. In addition, the sample size was small and hence more research should be conducted before solid conclusions ought to be made. Extending the sunlight exposure with a larger sample size should be investigated as an inexpensive measure as part of strategies to improve the vitamin D status among high-risk adult females in the UAE. Future studies should include a group of participants taking oral vitamin supplements.

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