Original Article

Serum vitamin D status of Korean postmenopausal women during the winter months

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Objective: To determine the vitamin D status of Korean postmenopausal women during the winter months according to the intake of vitamin D supplements. Design: Cross sectional study of serum 25(OH)D levels according to the intake of vitamin D supplements in postmenopausal women. Method: Between November 2006 and February 2007, 254 postmenopausal women who visited our menopausal clinic for hormone therapy or osteoporosis medication were recruited. Serum 25(OH)D levels were measured with a radioimmunoassay kit and the results were compared among groups that were classified according to the intake amount of vitamin D supplements. Results: The mean serum 25(OH)D level was 83.3 ± 32.8 nmol/L and it increased as the intake amount of vitamin D supplements increased. The mean serum 25(OH)D level was not significantly different between groups 1 (no vitamin D supplements) and 2 (daily 100-300 IU supplements). However, the mean serum 25(OH)D level was significantly higher in group 3 (daily 400 IU supplements) than in group 1. While the mean value of group 4 (daily 600 IU) was not significantly different from that of group 3, it was significantly lower than that of group 5 (daily 800-900 IU). Conclusion: Vitamin D supplementation is highly effective in improving vitamin D status and the vitamin D status in this study population was improved considerably when compared to previous studies. Therefore, it is concluded that the prevalence of vitamin D insufficiency should be re-evaluated in postmenopausal women in most countries including Korea.

Key Words: vitamin D status, Korea, postmenopausal women, winter, vitamin D supplements

INTRODUCTION

Recently, vitamin D deficiency has been defined as a 25-hydroxyvitamin D [25(OH)D] level of less than 50 nmol/L and a level of 21-74 nmol/L is considered relative insufficiency of vitamin D although there is controversy on the optimal serum level of vitamin D.[1] Under the definition mentioned above, it has been estimated that 1 billion people worldwide fall into either of the 2 categories: vitamin D deficiency or insufficiency.[2-5]

Differences in the prevalence of vitamin D insufficiency have been reported to be related to various factors, including age, race, body mass index (BMI), sun exposure, geographical location, dietary vitamin D intake, daily activity and exercise level.[1,5] In North America, the prevalence of a low serum 25(OH)D concentration (< 75 nmol/L) is 52%.[5] In Europe, where very few foods are fortified with vitamin D, children and adults appear to be at high risk for vitamin D insufficiency. Lips et al[6] have reported that the prevalence of 25(OH)D levels less than 50 nmol/L varies from 17% to 44% according to different regions. Vitamin D insufficiency in Asia is widespread among both younger and older adults, regardless of regions or seasons. There may be variations between ethnic groups but the problem of insufficiency is highly prevalent, particularly in people with an urban lifestyle. Korea lies at latitude of 33 degrees to 43 degrees north, and thus is considered to have abundant sunlight. Due to the abundant supply of sunlight, nutritional vitamin D status had not yet been mentioned and the additional supply of vitamin D from diet had also been neglected. However, Lim et al[7] have reported that the prevalence of vitamin D levels of less than 75 nmol/L was 92%, and Park et al[8] have reported that the mean serum 25(OH)D level of Korean postmenopausal women during the wintertime was 30.5 nmol/L. Also, the prevalence of 25(OH)D levels less than 50 nmol/L during the wintertime was 90.1%.[9] With recently increased awareness of the importance of vitamin D, the general population has focused on vitamin D intake, and thus the number of people who take vitamin D supplements has increased. For this reason, the prevalence of vitamin D insufficiency might have been lowered. Therefore, we conducted this study to determine the vitamin D status of Korean postmenopausal women during the winter months according to the intake amount of vitamin D supplements.

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SUBJECTS AND METHODS

Between November 2006 and February 2007, 254 postmenopausal women who visited our menopausal clinic for hormone therapy or osteoporosis medication were recruited. They had been verbally instructed about the importance of vitamin D, exercise, and sun exposure on visit by their physician.

Women with a history of metabolic bone disease, systemic glucocorticoid therapy or use of antiepileptic drugs were excluded. Women who were treated with hormone therapy or osteoporosis medication were included.

They were required to answer the name of the vitamin complex or vitamin D supplements that they were taking and their intake amount per day. The intake amount of vitamin D-containing food, calcium, calcium containing food and the amount of sun exposure were not considered. The total intake amount of vitamin D supplements was calculated by the study coordinators. The study coordinators calculated the amount of vitamin D by asking patients the brand and ingested dose of vitamin D or multivitamin. No clinical signs of vitamin D deficiency were observed. All women gave a written informed consent. This study was approved by the local ethics committee.

Blood samples were collected using a bottle protected from sunlight and sent to the laboratory for serum 25(OH)D level assessment. Fasting was not required. The serum 25(OH)D level was measured with a radioimmunoassay kit (Diasorin, Nivelles, Belgium).

Statistical analysis

Statistical analyses were performed using SPSS version 13.0. Analysis of variance (ANOVA) was applied to compare the differences in serum vitamin D levels between the groups. All statistical comparisons were made with the multiple comparison tests (Duncan test).

RESULTS

Subject characteristics are summarized in Table 1. About 70 percent of subjects were taking hormones, but the hormone therapy did not affect vitamin D status. Thirty six percent of subjects reported that they did not take vitamin D supplements (group 1) and twenty percent of them reported that they took 100-300 IU of vitamin D daily (group 2). While thirty-one percent of subjects reported to be taking 400 IU of vitamin D daily (group 3), three percent of them reported to take 600 IU (group 4). Finally, 10 percent of them reported to take 800-900 IU daily (Table 2).

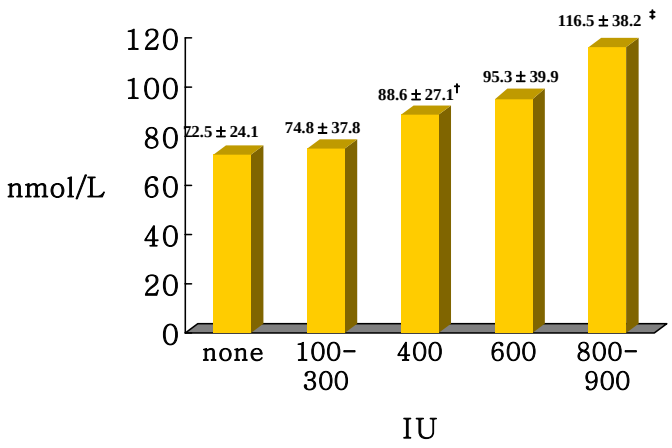
Table 1. Subject characteristics (n = 254).

Characteristics	Number
Age (yr), mean (SD)	58 (8)
BMI (kg/m2), mean (SD)	23.3 (2.7)
Lowest T-score, mean (SD)	-1.15 (1.13)
Hormonal therapy, n (%)	
Estrogen with or without progestogen	152 (60)
Tibolone	26 (10)
Phytoestrogen	4 (1.6)
Osteoporosis medication, n (%)	
Bisphosphonate medication	77 (30)
Raloxifene	7 (2.8)

Table 2. Daily intake of vitamin D supplements (n = 254).

Vitamin D supplementation, IU/day	Number (%)
None	91 (36)
100-300	51 (20)
400	79 (31)
600	8 (3)
800-900	25 (10)

The mean serum 25(OH)D level was 83.3 ± 32.8 nmol/L and it increased as the intake amount of vitamin D supplements increased (Fig. 1). Forty-four percent of subjects had a serum 25(OH)D level of less than 75 nmol/L, and 13 percent of them had a serum 25(OH)D level of less than 50 nmol/L. The prevalence of vitamin D insufficiency at a cut-off point of 75 nmol/L decreased as the intake amount increased (Fig. 2). The mean serum 25(OH)D level was not significantly different between groups 1 and 2. However, the mean serum 25(OH)D level was significantly higher in group 3 than in group 1. While the mean value of group 4 was not significantly different from that of group 3, it was significantly lower than that of group 5.



†p<0.05 vs none, ‡p<0.05 vs 600 IU

Figure 1. The mean level of 25(OH)D according to the intake amount of vitamin D supplements.

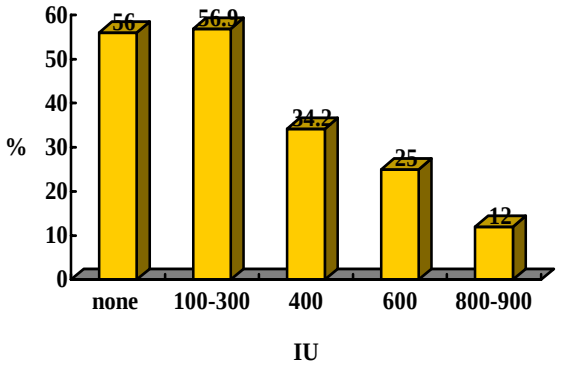


Figure 2. Subgroup analysis of the prevalence of vitamin D inadequacy according to the intake amount of vitamin D supplements.

DISCUSSION

A recent meta-analysis of primary prevention trials has reported that oral vitamin D supplements between 700 and 800 IU per day reduces the relative risk of hip fracture by 26% and non-vertebral fracture by 23%, while an oral vitamin D dose of 400 IU is not sufficient for fracture prevention.[10] Antifracture efficacy was observed with the maintenance of a mean serum 25(OH)D level of at least 75 nmol/L and this serum level was reached only in trials that provided 700-800 IU vitamin D (cholecalciferol) per day.[11] Based on these results, vitamin D deficiency is defined as a 25(OH)D level of less than 50 nmol/L and a 25(OH)D level of 51-74 nmol/L is considered to be a relative insufficiency of vitamin D.

In this study with 254 Korean postmenopausal women, we found a relatively high prevalence of vitamin D insufficiency. However, this study revealed a lower prevalence and a higher mean concentration of vitamin D than a previous study which reported the prevalence of vitamin D insufficiency to be 92% and the mean concentration to be 51 nmol/L.[8] A plausible explanation for this result is that Korean physicians are aware of the very high prevalence of vitamin D insufficiency and encourage patients to get adequate sun exposure and to take vitamin D supplements. Bischoff-Ferrari et al[12] have reported that the current intake recommendation for older persons (600 IU/day) may bring concentrations in most individuals to 50-60 nmol/L but not to 75-100 nmol/L. If 75 nmol/L were the minimum target level of a recommended daily allowance (RDA), the new RDA should meet the requirements of for 97% of the population.[13] For this purpose, Haddag et al[14] suggested that a daily dose of 2,000 IU may be the safe RDA at the higher end of the normal 25(OH)D serum level distribution and may be conservative at the lower end. Our study showed that 90% of postmenopausal women took vitamin D less than 700 IU/day, while 44% belonged to the insufficiency group. In addition, the mean serum 25(OH)D level was significantly higher in the group that took 400 IU/day than in the group that did not take vitamin D supplements, and it was significantly higher in the group that took more than 800 IU/day than in the group that took 400 IU/day. Therefore, physicians should emphasize the need for adequate intake of vitamin D and subsequently lower the prevalence of vitamin D insufficiency.

The results of this study should be considered in context and thus some of its limitations should be discussed. First, we did not consider the factors potentially influencing serum 25(OH)D concentration, such as the limitation of daily activities, the amount of exercise per week, the intake amount of vitamin D-containing foods, calcium supplements, calcium containing foods and sun exposure. Thus, it is thought that the subjects in this study may have ingested higher doses of vitamin D than the doses calculated by the coordinators. Insignificant differences in vitamin D concentration between group 1 (no vitamin D supplements) and group 2 (daily 100-300 IU supplements) as well as between group 3 (daily 400 IU supplements) and group 4 (daily 600 IU supplements) could have resulted from the above reason. Second, since the serum level of parathyroid hormone was not measured in this study, it cannot be confirmed whether the cut-off value of the optimal concentration can be defined as 75 nmol/L in Korean postmenopausal women. Cho et al[15] have reported that there is a plateau level at 22 pg/mL for the serum level of PTH at a 25(OH)D concentration higher than 60 nmol/L in the Korean general population. Further studies are required to determine whether the optimal vitamin D concentration varies between different races. Third, since more than 70% of the subjects in this study had received hormone therapy, they may not accurately represent the general postmenopausal women in Korea. They visited our clinic at regular intervals and were instructed about the importance of vitamin D supplementation, exercise, and sun exposure. It is conceivable that serum vitamin D levels were higher in the subjects than that of the menopausal women in the general population, since a larger number of subjects might have been taking vitamin D supplements than those of the general population.

Lastly, since this is a cross sectional study that checked the status of vitamin D during the winter months and the amount of daylight varies substantially season to season in Korea, it can not be stated that the results of this study represents the mean serum vitamin D level.

In summary, although vitamin D supplementation is highly effective in improving vitamin D status, a large number of Korean postmenopausal women suffered from vitamin D insufficiency and most of them took less vitamin D than what the RDA recommends. However, it was found that the vitamin D status of the study subjects were greater than what was found in previous studies. There-

fore, it is concluded that the prevalence of vitamin D insufficiency should be re-evaluated in postmenopausal women in most countries including Korea.

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AUTHOR DISCLOSURES

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韓國停經婦女在冬季的血清維生素 D 的狀態

目的：根據維生素 D 補充劑攝取量，探討韓國停經婦女在冬季的維生素 D 的狀態。研究設計：利用橫斷性研究，探討停經婦女中，攝取維生素 D 補充劑，血清 25(OH)D 的濃度。研究方法：2006 年 11 月至 2007 年 2 月，本研究招募了 254 位到更年期門診而使用荷爾蒙療法，或使用骨質疏鬆症治療藥物的停經婦女。利用放射免疫分析試劑測量血清 25(OH)D 的濃度，並根據維生素 D 補充劑的攝取量去做分組比較。結果：25(OH)D 的平均值為 83.3±32.8 nmol/L。隨著維生素 D 補充劑攝取提高，血清 25(OH)D 的濃度也增加。在第一組(沒有使用維生素 D 補充劑)和第二組(每日攝取 100-300 IU 的維生素 D 補充劑)的 25(OH)D 平均值沒有顯著的差異。然而，第三組(每日攝取 400 IU 的維生素 D 補充劑)的血清 25(OH)D 平均值顯著高於第一組。儘管第四組(每日攝取 600 IU 的維生素 D 補充劑)的血清 25(OH)D 平均值沒有顯著不同於第三組，但顯著低於第五組(每日攝取 800-900 IU 的維生素 D 補充劑)的 25(OH)D 平均值。結論：維生素 D 補充劑是非常有效地改善維生素 D 的狀態。比起以往的研究，本研究的族群之維生素 D 狀態有相當大的改善。因此，本篇推論停經婦女在大多數國家，包括韓國在內，維生素 D 缺乏的盛行應重新評估。

關鍵字：維生素 D 狀態、韓國、停經婦女、冬季、維生素 D 補充劑