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The Influence of Dietary Intake and Sunlight Exposure on the Vitamin D Status in an Elderly Spanish Group

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Summary: Traditional dietary habits and the living style in Spain should theoretically be enough to assure a healthy vitamin D status: a very high fish intake and one of the highest sun exposure rates of all countries in Europe. However, in spite of this, there is a high percentage in the elderly showing low vitamin D serum values. This paper is part of the Euronut-SENECA study, a major multicentre survey assessing the nutritional status in the elderly from 19 centres over 12 countries in Europe. In it, the vitamin D status in 55 healthy individuals from Spain has been studied and assessed by measuring dietary and supplemental vitamin D intakes; the influence of sunlight exposure such as physical activity, permanence in the sun, clothing, etc.; and 25-hydroxyvitamin D [25 (OH)D] serum concentration. The mean dietary intake was 1.3 ± 1.5 μg/day, being fish, and specially fatty fish, the main source (62%). Of the total, 85% of the elderly did not reach the Spanish recommended dietary intake (2.5 μg/day). The mean 25(OH)D serum level was 25 ± 14.7 nmol/l and there was a high percentage with deficit (13%) (8.4 ± 1.9 nmol/l) and marginal (62%) (19.8 ± 4.2 nmol/l) levels. People who usually walked 1.9 ± 1.3 hours/day or stayed in the sun «every day» or «as much as possible», had higher ($p < 0.05$) serum 25 (OH)D concentrations (27.7 ± 2.4 nmol/l and 31.3 ± 3.7 nmol/l, respectively) than people who did not (16.6 ± 1.2 nmol/l and 21.3 ± 2.1 nmol/l, respectively). There seems to be some relationship between the elderly group which wore no clothing cover or light clothing and a higher vitamin D serum level (34 ± 27 nmol/l) and a lower vitamin D serum level for the elderly group which wore a jacket, coat, suit or sweater (20 ± 16 nmol/l). In conclusion, neither does the effect of sunlight exposure on cutaneous vitamin D synthesis, although important for this elderly group, nor does the daily intake supply sufficient vitamin D to maintain adequate 25(OH)D levels. A possible remedy would be either to increase the time of sunlight exposure with no or little clothing cover or to take vitamin D supplements.

This paper belongs to the Euronut-SENECA Study on Nutrition and the Elderly in Europe.

Introduction

It is well recognized that vitamin D status depends equally upon cutaneous synthesis as well as upon dietary intake and that either source is capable of supplying the total daily vitamin D requirement, and the relative contribution of these two sources varies widely among individuals [1]. However, diet is not a good total vitamin D source because the only natural foods which contain a significant amount of vitamin D are fatty fish (sardine, tuna, swordfish, mackerel, etc.), eggs, and liver, but if these foods are not ingested, the vitamin is resultingly

scarse. Due to this fact, most countries often fortify foods like milk, cereals, and margarin with extra vitamin D. Moreover, in several countries, some people consume additional vitamin D supplements [2]. In populations with very low vitamin D dietary intake, sun exposure provides the main determinant for plasma 25-hydroxyvitamin D [25(OH)D], not only in summer but also for winter production requirements [2, 3, 4, 5]. Cutaneous vitamin D synthesis depends upon factors such as geographical location, seasonal variations, atmospheric conditions, indoor or outdoor work, extent of outdoor leisure activities, customary use of protective clothing, degree of skin pigmentation and some other factors, but not upon nutritional factors [1].

Several studies have revealed an insufficient vitamin D status in the elderly influenced by many factors related to health status, living conditions and sunlight exposure, such as low dietary intake, impaired intestinal absorption, lack of sunlight exposure, reduced cutaneous production, etc. [2, 6, 7, 8]. As a result, it is difficult to define precise vitamin D requirements in the elderly. Elsewhere, it has been suggested that 15 to 20 µg/day or 50 to 100% above the current recommendation for young adults are «safe» limits [3]. This requirement should make up the total vitamin D supply from all sources: diet, oral supplements and sunlight [9].

In Spain, some of the dietetic habits and living style characteristics should assure a healthy vitamin D status due to the high fish intake (69.4 g/day) [10], and also because Spain is one of the sunniest countries in Europe. However, preliminary data from the Euronut-SENECA study, a major multicentre survey assessing the nutritional status in the elderly from 19 centres over 12 European countries [11], showed relatively low plasma 25(OH)D levels [12]. Surprisingly, in this study, the lowest mean values for vitamin D serum levels were observed in Greece, Italy and Spain, all of them Mediterranean countries. These results suggest «somewhat different attitudes towards sunlight, meaning that the elderly living in Southern countries try to avoid sunshine» [12]. Some differences among different countries could be related to supplementary intake and the results of food fortification methods.

The aim of the present study was to analyze the peculiarities of the vitamin D status in the elderly spanish group included in the Euronut-SENECA study. The Vitamin D intake from foods and supplements, sunlight exposure habits (staying in the sun, walking time, clothing, and use of sun lamps) were studied and related to their 25(OH)D serum levels.

Subjects and Methods

Subjects: The study was carried out in Betanzos (Spain) in a random subsample of 55 elderly individuals born between 1913 and 1918 - 25 men and 30 women - selected from a total of 207 - 88 men and 119 women.

Methods: The general protocol used, as described elsewhere [13], consisted of several parts, of which sections reflecting vitamin D study were used:

1) General questionnaire. Information on life-style, self-perceived health, physical activities, sunlight exposure habits, etc., was recorded.
2) Dietary intake. Food consumption data was obtained through a modificated version of the dietary history [14]. It consisted of an estimated 3-day record to provide information on the subjects's eating habits, which could be helpful in assessing the subject's usual intake, using the preceding month as the reference period, and based on a local food checklist. The interviewer completed the checklist by recording the usual size of food portions in household measurements, where the size of the food portions frequently used were weighed by the interviewer. Food consumption data was converted into energy and nutrient intake by using the Food Composition Tables for Spain [15].
3) Biochemical measurements. The vitamin D status was determined by measuring serum 25(OH)D levels. Fasting venous samples were drawn in February of 1989 and serum aliquots were stored at -80°C until the analyses were performed (CIVO/TNO, Zeist, The Netherlands).
4) Statistical analyses. Student's t test; non-parametric test (Mann-Whitney test); analysis of variance which takes into account more than one factor, and correlation coefficients were used for the analyses of the data. In all tests, a p value of less than 0.05 was considered significant.

Results and Discussion

The mean daily vitamin D intake was 1.3 ± 1.5 µg/day which represents only 53% of the Recommended Dietary Intake for Spain (RDI) - 2.5 µg/day - which in turn, is one of the lowest

Table I: Vitamin D intake

	Total X±SD	Percentile distribution P25	P50	P75	P90	Men X±SD	Women X±SD
Vitamin D (μg/day)	1.3± 1.5	0.5	0.9	1.6	2.9	1.4± 1.4	1.3± 1.6
% of RDI*	53 ±60	19	36	66	116	61 ±60	51 ±67

* RDI = Recommended Dietary Intake for Spain (2.5 μg/day)

in Europe [16]. There was a high percentage of people with low intakes as shown in the percentile distribution: 83% of the elderly were below the RDI (81% of men and 85% of women). There were no significant gender differences (Tab. I).

The main vitamin D dietary source was fish (86±70 g/day), but what is more significant, approximately one-third of the intake came from fatty fish (mainly sardine, tuna and swordfish). This food group represents 62% (0.66± 1.47 μg/day) of the total vitamin D intake, although it is important to consider that fatty fish in winter have lower fat content. Eggs (25± 20 g/day) provided 20% (0.45±0.30 μg/day) and dairy products (517±291 g/day), only 8% (0.18±0.12 μg/day). Since there are no vitamin D fortified foods in Spain, these food groups represent the only source for vitamin D. This low vitamin D dietary supply, and the fact that there were not subjects taking vitamin D supplements as described by AMORIM CRUZ *et al* [17], makes this elderly group dependent upon cutaneous vitamin D synthesis to complete their requirements.

Sun exposure habits as recorded by the general questionnaire were not satisfactory: 85% of the elderly usually walked 1.9±1.3 hours/day (the only sun exposure activity), but most of them (56%) tried to avoid sunshine and a high percentage (45%) wore a jacket, coat, suit or sweater when they went out. None used sunlamps, and moreover, most of the subjects were unaware of their existence.

Subsequently, the 25 (OH)D serum data was below the adequate levels (30–60 nmol/l) as shown in Table II, with high inter-individual variations. According to the cut-off points provided by Hoffmann-La Roche, a high percentage of individuals with deficient (13%) (8.4±1.9 nmol/l) and marginal (62%) (19.8± 4.2 nmol/l) levels exists (Fig. 1). The prevalence

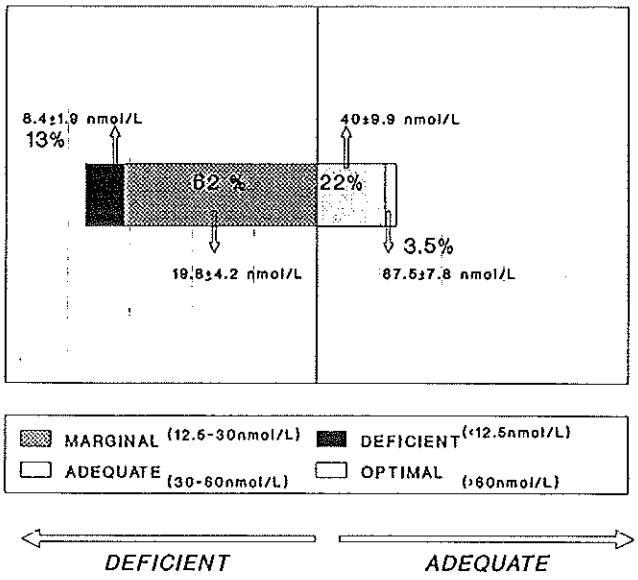

Figure 1: Biochemical vitamin D status (% of elderly) (X±SD)

Table II: Vitamin D serum levels (nmol/l) (X±SD)

	Total	Men	Women
25(OH)D	25.3±14.7	30.9±18.8	21.4±8.3*

* $p<0.05$

of low levels (<25 nmol/l) in the Euronut-SENECA study showed 23% for men and 33% for women and values below 12.5 nmol/l were found for 3% and 5%, respectively [12]. The values for men were significantly higher ($p<0.05$) than for women (Tab. II). These results are comparable to other studies [1, 3, 12, 18], but are the opposite of those observed by LAMBERG-ALLARDT [5]. Also, there was no correlation between intake and serum levels as observed by other authors [4].

People who normally «avoid sun» had lower vitamin D serum levels (21.3±4.3 nmol/l) than those who stay in the sun «every day» or «as much as possible» (31.3±15.6 nmol/l) ($p<0.05$)

(Fig. 2). It should be noted that there seems to be some relationship in the elderly who go out with no clothing cover or light clothing and a higher vitamin D serum level (34±27 nmol/l) whereas a lower vitamin D serum level is shown for the elderly who wear a jacket, coat, suit or sweater when out in the sun (20±16 nmol/l) (Tab. III).

Table III: Outdoor clothing during sunny months Vitamin D serum levels (nmol/l)

	N	X±SD
Jacket, coat, suit or sweater	9	20±16
Long sleeved shirt, blouse, dress or T-shirt	16	27±11
Short sleeved shirt, blouse, dress or T-shirt	22	25±14
Light beach clothes or swimwear	5	34±27

N: Number of subjects

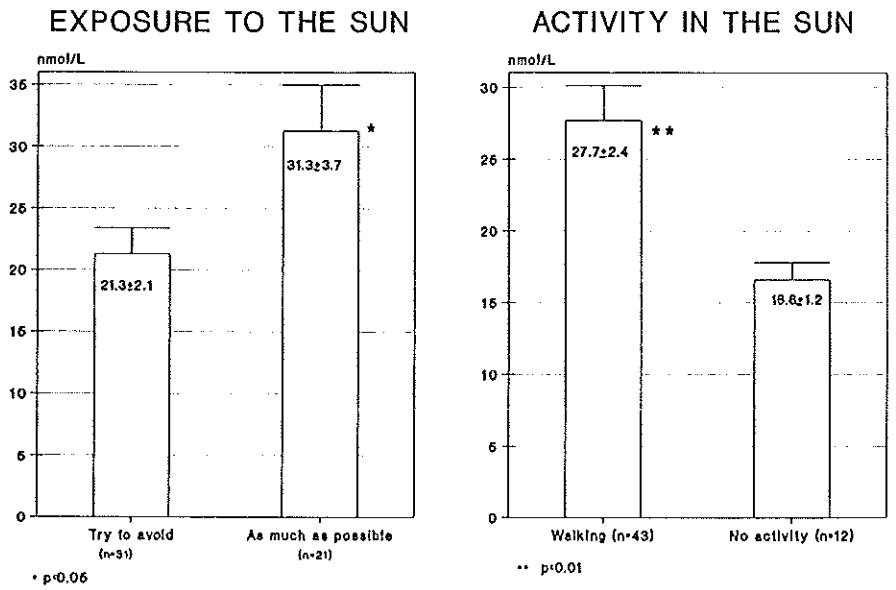

Figure 2: Vitamin D serum levels (X±SE)

A positive correlation ($r=0.377$) ($p<0.05$) between vitamin D serum levels and walking time, the only sun exposure activity, has been observed. Those people who walked in the sun 1.9±1.3 hours/day, had significantly ($p<0.01$) higher vitamin D serum levels (27.7±15.6 nmol/l) than people who did not walk (16.6± 4.3 nmol/l), though the elderly with higher walking time still had inadequate vitamin D levels (Fig. 2).

So even for this group, a high fatty fish intake and sunlight exposure are not sufficient to create adequate 25(OH)D serum levels. This may be due to the relatively high percentage of individuals who normally avoid sunlight. To compensate, one suggestion would be to increase the sunlight exposure time with no or little clothing cover, or another would be to take a vitamin D supplement (10 µg/day), as has been previously postulated [2, 7]. On the other hand, it might also be advisable to reconsider the current vitamin D RDI level (2.5 µg/day) for the elderly in Spain.

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