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Prevention and treatment of vitamin D deficiency in Dutch psychogeriatric nursing home residents by weekly half-body UVB exposure after showering: a pilot study

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Abstract

Background: in older people, induction of cutaneous vitamin D production by ultraviolet B (UVB) exposure may be preferable to oral supplementation: it cannot cause toxic levels, it helps to prevent polypharmacy and, moreover, there are indications that UVB exposure has beneficial effects on health and well being by mechanisms other than the vitamin D pathway alone.
Objective: the aim of this pilot study is to investigate whether weekly, half-body, UVB irradiation after showering can increase serum 25-hydroxyvitamin D (25(OH)D) to sufficient levels, in a Dutch psychogeriatric nursing home population.
Method: subjects were eight psychogeriatric nursing home patients, mean age: 79 ± 8. Exclusion criteria were going outdoors into the sun more than once a week, the presence of actinic or cancer skin lesions and known resistance to body contact. The intervention consisted of weekly half-body UVB irradiation, after showering, over 8 weeks, with 0.5 minimal erythemal dose (MED). Main outcome measures were change in fasting serum levels of 25(OH)D and parathyroid hormone (PTH) at 0, 2, 4 and 8 weeks.
Results: at baseline, mean serum 25(OH)D was 28.5 nmol/l. Mean serum 25(OH)D levels increased to 46.5 nmol/l. Median serum PTH levels decreased by 20% after 8 weeks of treatment.
Conclusion: an 8 week course of weekly, frontal half-body irradiation with UVB, at 0.5 MED, leads to an significant increase in 25(OH)D serum levels, but this period is too short to reach vitamin D sufficiency.

Keywords: *vitamin D, UVB, nursing home*

Introduction

Vitamin D deficiency [25-hydroxyvitamin D (25(OH)D) <25 nmol/l] and vitamin D insufficiency (25(OH)D < 50 nmol/l) is common in older people, in particular in nursing home residents [1, 2]. Vitamin D deficiency causes secondary hyperparathyroidism, which leads to cortical bone loss [3]. It may also lead to fatigue, muscle weakness and falls [4, 5]. Vitamin D deficiency thus contributes to the pathogenesis of osteoporosis and fractures.

However, the vitamin D receptor has been found in many other tissues and vitamin D deficiency is associated with multiple health problems such as increased risk of common cancers, autoimmune diseases, hypertension, knee cartilage loss, pain, cognitive impairment and depression [6–11].

In humans and most other species the most important way for obtaining an adequate vitamin D status is sunlight [ultraviolet B (UVB) part] exposure [12]. In nursing home residents in particular, the most common cause of

vitamin D deficiency is not going outside in the sun. The production of vitamin D_3 at the age of 80 (aged skin) is around 25% of that of the age of 20 [13]. Nevertheless in older nursing home residents, three times a week artificial UVB irradiation, on a limited area of the skin, proved to be equally effective as oral vitamin D supplementation, in correcting vitamin D deficiency [14].

Induction of cutaneous Vitamin D production by UVB exposure may be preferable to oral supplementation in older nursing home residents, because it cannot induce toxic levels; the use of UVB lamps is a feasible and economic alternative for sunshine exposure and has the additional benefit that it can provide cutaneous vitamin D synthesis throughout the year; it helps in preventing polypharmacy and it is plausible that vitamin D production is not the only pathway whereby sunlight or UVB exposure has beneficial effects on human health and well being [15].

In order to investigate, in a larger follow-up study, whether artificial UVB exposure has an additional value on quality of life of older nursing home residents in correcting vitamin D deficiency, the aim of this smaller pilot study is to investigate whether, in a Dutch psychogeriatric nursing home population, half-body, full frontal UVB irradiation, only once a week, after showering, is feasible and effective in obtaining vitamin D sufficiency (serum 25(OH)D > 50 nmol/l).

Subjects and methods

Subjects were five female and three male residents of low and medium care wards of the psychogeriatric nursing home Mariënhaven in Warmond (The Netherlands/latitude: 52°N) with a mean age of 79 (71–87). Exclusion criteria were going outdoors into the sun more than once a week; the use of vitamin D supplements; the presence of actinic or cancer skin lesions and known anxiety, agitation or resistance to body contact. The presence of actinic or cancer skin lesions as well as the skin type was checked by a dermatologist. All subjects had skin Type 2 or 3. The estimation of the skin type was based on the skin and eye colour of the participants and on the recollection of their relatives as regarded the sun exposure of the participants [16]. The dietary vitamin D intake of this population was 100 IU/day and the calcium intake was 1,000 mg/day [2, 17]. Written informed consent was obtained from proxies and treatment was discontinued when participants clearly objected or showed signs of discomfort. The protocol was approved by the Ethical Review Board of the VU University Medical Centre Amsterdam. Once a week, over a period of 8 weeks, after showering, all participants received UVB irradiation at 1.0 standard erythema dose (SED) = a CIE (Comite International de l' Eclairage) dose of 100 J/m^2 = 50% of the minimal erythema dose (MED) for skin Type 2 (2 min at 1 m distance from the UVB lamps). UVB irradiation took place while seated in a standard, comfortable, electrically adjustable, Carendo® bathroom chair; the same chair in which the participants were showered. For the UVB irradiation, an obliquely installed Hapro® sunbed was used with 2 Philips® 100W/12 (high UVB intensity) and 8 Philips® Cleo sunbed TL lamps. Before first use, the sunbeds were tested at the dermatology department of the Leiden University Medical Centre. During the UVB irradiation the eyes of the participants were protected.

Fasting blood samples were taken at 0, 2, 4 and 8 weeks. Samples were processed within 2 h after drawing and serum was stored at −23°C. Serum 25(OH) was measured by radioimmunoassay (Diasorin, Stillwater, MN, USA) with an inter-assay coefficient of variation (CV) of 10% at 30 nmol/l. Serum PTH was measured by radioimmunoassay (Incstar, San Juan Capistrano, CA, USA) with an inter-assay CV of 10% at 3.5 pmol/l. For these parameters, the sera of a single participant were all measured within the same run to decrease variation. Analyses were done in duplicate. The VUmc laboratory adhere to quality assessment schemes (DEQAS and SKML). Serum calcium, phosphate, albumin, creatinine and alkaline phosphatase were measured using standard laboratory procedures, immediately after obtaining the blood samples.

Statistical analysis

Statistical analysis was performed using SPSS version 17.0. The effect of treatment was tested by using paired *t*-tests on the serum levels at Week 0 versus Week 8. $P < 0.5$ was considered statistical significant.

Results

The mean age of the participants was 79 ± 8 years. No skin erythema or other complications developed during the study. All but one of the participants were vitamin D insufficient (serum 25(OH)D < 50 nmol/l) at t_0. Serum levels of 25(OH)D and PTH in each individual during the study period are shown in Figures 1 and 2. Serum levels of

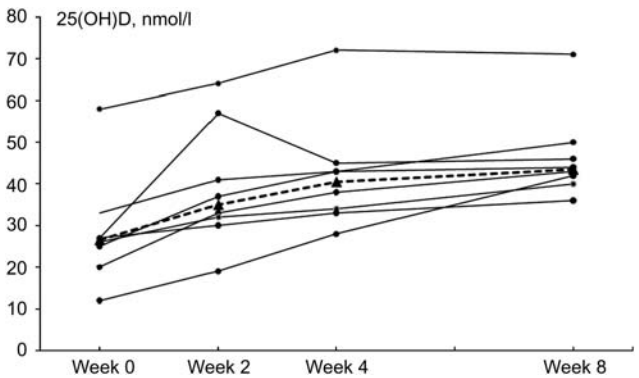

Figure 1. Serum 25(OH)D levels in individual participants at each follow-up moment. The dotted line represents the median values.

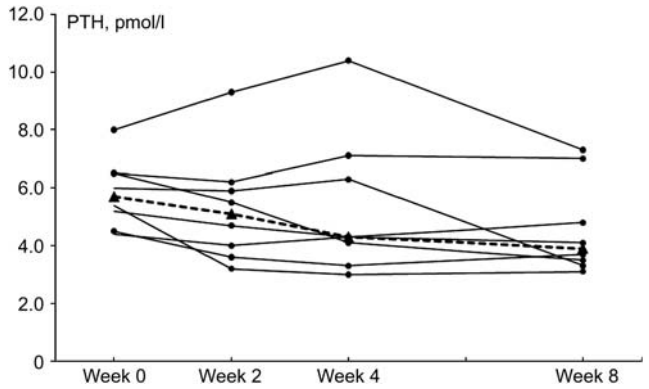

Figure 2. Serum PTH levels in individual participants at each follow-up moment. The dotted line represents the median values.

calcium, albumin, alkaline phosphatise, phosphate and creatinine are shown in Table 1.

Serum 25(OH)D increased in all individuals and the median serum 25(OH)D increased from 26.5 nmol/l (12–58) at baseline (t_0) to 43.5 nmol/l (36–71) after 8 weeks (t_3) ($P < 0.001$).

Although the median serum PTH at baseline was not increased in most participants compared with values obtained in young adults (reference value 1.1–6.3 pmol/l), it decreased from 5.7 pmol/l (4.4–8.0) at t_0 to 3.9 pmol/l (3.1–7.3) at t_3 ($P = 0.03$).

Discussion

The results of this pilot study confirm the poor vitamin D status usually observed in nursing home residents. In all participants serum 25(OH)D levels increased with UVB exposure, vitamin D sufficiency, however, was not reached in most subjects. Because serum 25(OH)D levels continued to increase during the study period, it is to be expected that vitamin D sufficiency can be reached with the same UVB exposure over a longer period or with UVB exposure at 90% MED (by increasing the exposure time per session or by using more high intensity UVB lamps). The nursing staff reported that the weekly UVB irradiations were appreciated by the participants and easy to perform.

In this pilot study, UVB exposure was full frontal, at 0.5 MED once a week after showering. In an earlier study, also in a Dutch psychogeriatric nursing home, the effect of UVB exposure applied at an area of 1,000 cm^2 of the lower back, three times a week at half the individual MED, was compared with oral vitamin D3 400 IU/day. Baseline serum 25(OH)D was lower than 30 nmol/l in 95% of the participants in the previous study and increased to a median value of around 60 nmol/l after 12 weeks. Serum PTH decreased more than 30%. The administered UVB exposure was as effective as the oral dose given, in increasing serum 25(OH)D and suppressing secondary hyperparathyroidism [14].

Although oral vitamin D3 supplementation is effective and easy to perform, induction of cutaneous vitamin D production by UVB exposure can be equally effective and possibly has additional health benefits. The beneficial role for UVB on some auto-immune diseases (multiple sclerosis; insulin-dependent diabetes mellitus and rheumatoid arthritis) is linked to suppression of T helper cell Type 1 mediated immune responses, possibly through several other mechanisms apart from vitamin D effects (i.e. apart form other pathways, UV radiation has a direct immunosuppressive effect. UVB possibly can up-regulate secretion of TNF-alpha, IL-10 and T regulatory cells, providing both local and systemic immunosuppression) [15, 18–21]. Although UV exposure is considered to be the major cause of skin cancer, in several studies an inverse correlation was found between sunlight and mortality or incidence of colorectal, prostate, breast and ovary cancer and it was questioned whether vitamin D synthesis is the only mechanism by which sunlight exerts its possible preventive effect on these cancers [15, 21–25]. Going outside into the sun and obtaining a tan, rightly or wrongly, is generally associated with a feeling of well being and good health [21–23, 25]. Especially in older nursing home residents this perceived feeling of good health is likely to be combined with a more active social life as a result of leaving the nursing home more often and may have an important effect on the quality of life in this frail population.

We conclude that UVB exposure, at 0.5 MED, once a week, of the frontal half of the body, after showering, leads to an important improvement of the vitamin D status in older nursing home residents. Eight weeks, however, were not enough to reach vitamin D sufficiency.

Table 1. Mean, standard deviation (SD) and median for biochemical parameters in blood at baseline (Week 0) and after 8 weeks

Serum concentration	Refs	Week 0			Week 8		
		Mean	SD	Median	Mean	SD	Median
Calcium (corrected), mmol/l	2.25–2.55	2.44	0.06	2.42	2.49	0.08	2.48
Albumin, g/l	40–50	34.63	2.82	34.50	32.38	3.85	31.00
Phosphate, mmol/l	0.81–1.45	1.06	0.10	1.06	1.14	0.11	1.15
Alkaline phosphatase, U/l	40–120	83.25	18.08	86.00	84.75	20.56	89.00
Creatinine, µmol/l	70–133	79.88	14.23	78.00	80.75	19.45	78.50

We will now carry out a follow-up study, to investigate whether weekly UVB exposure throughout the year, has an added value on quality of life of elderly nursing home residents in correcting vitamin D deficiency compared with oral vitamin D supplementation.

Key points

- The results of this study confirm the widely observed finding that nursing home residents are deficient in vitamin D.
- UVB exposure is effective to increase the plasma 25-OH vitamin D concentration in older people. Weekly UVB exposure of half the body surface at 0.5 MED for 8 weeks does not result in vitamin D sufficiency.

Conflicts of interest

None declared.

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