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Vitamin D25-OH concentration in outpatient and hospitalized geriatric patients – retrospective study

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ABSTRACT

A majority of the Polish population was found to have vitamin D deficiency. The problem was expected to grow in the elderly during the COVID-19 pandemic related lock down. The aim of the study was to compare concentrations of vitamin D in the blood sera of geriatric patients treated in outpatient clinics or hospitalized – and in the methods of treatment used. A retrospective study of the records of patients of the Rheumatology Outpatient Clinic and the Geriatrics Ward in Lublin was conducted.

In 2022, 80 people: 50 hospitalized women (HW) and 30 hospitalized men (HM) were admitted to the Geriatrics Ward in Lublin. Of these, 78 persons had vitamin D levels measured. From the Rheumatology Outpatient Clinic, medical histories of 68 outpatient women (OW) and 27 outpatient men (OM) 60+ were analyzed. In HW and HM, mean vitamin D concentration was 23 ng/ml and in OW and OM 25 ng/ml. The OW and OM with vitamin D concentration <30 received prescription for cholecacliferol 20 000 IU to be administered orally twice a week. The follow-up visit 2 was months later. Out of 47 OW, 17 came for the follow up and their results improved. Out of 21 OM, 100% returned, but their results were less satisfactory. The HW and HM received cholecalciferol 2000 IU. There was no follow-up.

In total, 41% of the outpatient elderly and 55% of the hospitalized had vitamin D concentration <20 ng/ml. Treatment of vitamin D deficiency with 20,000 IU cholecalciferol twice a week for two months is effective.

INTRODUCTION

Vitamin D is mainly (80-90%) an endogenous compound formed during irradiation of ergosterol with UVB rays (290-315 nm). UVB radiation can cover up to 90% of the body's needs for vitamin D. Factors affecting the synthesis of vitamin D in the skin include:

- latitude,
- season,
- time of day,
- environmental factors (smog, fog),
- the amount of melanin in the skin,
- the surface of the exposed body,
- use of creams with a protective filter against UVB radiation [1].

In Central Europe, in the period from October to March, there are no optimal sunlight conditions for the formation of sufficient amounts of vitamin D. The best time for skin synthesis is April – September [2]. In outdoor workers, however, exposure to solar UV radiation from April to October could be even harmful (carcinogenic) [3]. Daily exposure to solar radiation should last at least 15 minutes, be between 10.00 and 15.00 and cover at least 18% of the exposed body surface (forearms and lower legs), without using protective filters. Around noon, in January (in Spain), it takes more than two hours to obtain the recommended daily dose of solar radiation for synthesis of vitamin D. In the rest of the year, the recommended time of exposure to solar UV ranges between 7 min on July and 31 min on October [4].

The cause of vitamin D deficiency is low skin synthesis is related to latitude, modern lifestyle (in most First World countries, 90% of the day is now spent indoors), the use of UVB filters, aging, insufficient supply in the diet and chronic diseases (liver, kidney, malabsorption syndromes, obesity), as well as treatment with glucocorticoids or antiepileptic drugs.

Vitamin D deficiency is defined in one study as vitamin D 25-OH <12 ng/ml (30 nmol/l) and affects 10% of the

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European population [5]. In studies conducted in the northern and central eastern parts of the People's Republic of China, this deficiency is found in up to half of the population [6]. According to the Lancet, vitamin D deficiency defined as the value of vitamin D 25-OH concentration <20 ng/ml (50 nmol/l) may affect as much as 1/3 of the world's population [7].

Before the COVID-19 pandemic nearly 70% of all Poles displayed vitamin D deficiency or suboptimal concentration [8,9]. In the cited studies individuals aged >1 year were included. The risks of rickets were discussed, together with osteoporosis. There was no central European studies focusing on the elderly, however.

Vitamin D has a positive effect on the condition of the bones, affects the course of autoimmune, neurologic, as well as other diseases and prognosis in type 2 diabetes. Vitamin D supplementation also improves glucose tolerance and reduces insulin resistance [9-11].

The aim of the study was to compare the concentrations of vitamin D 25-OH in the blood sera of geriatric patients (>60 years old) treated in outpatient clinic or hospitalized settings, as well as assessing the effectiveness of the methods of treatment used. The null hypothesis was that both outpatient and hospitalized elderly patients had similar levels of vitamin D 25-OH in their blood sera.

MATERIALS AND METHODS

A retrospective study of the records of patients of the Rheumatology Outpatient Clinic of the Independent Public Health Care Center No 1 in Belzyce (Lubelskie Voivodship, Poland, 51°10'26'N, 22°16'48"E) and the Geriatrics Ward of the Cardinal Stefan Wyszynski Provincial Specialist Hospital Independent Public Health Care Center in Lublin, (Lubelskie Voivodship, Poland: 51°15'00"N, 22°34'00"E) was conducted in January 2023. The measuremets were undertaken between January 2022 and December 2022. The retrospective study did not require acceptance of the bioethical committee.

Patients aged 60+ with multimorbidity and patients over 65 years of age referred from the Geriatric Outpatient Clinic are hospitalized in this Geriatrics ward. The Rheumatology Outpatient Clinic is attended by patients aged 16+ referred by family doctors or specialists due to diseases and health problems classified in ICD-10 with the letter M. In 2022, 80 people (50 women and 30 men) were in-patients in the Geriatrics Ward in Lublin. Of these, 78 persons had their concentration of vitamin D 25-OH in blood serum measured. This is a standard procedure during hospitalization in this ward. Hospitalized women (HW) and hospitalized men (HM) were compared with outpatient women (OW) and outpatient men (OM). In the Rheumatology Outpatient Clinic, medical histories of all 60+ people were screened and 95 (68 women and 27 men) were selected. These were medical histories of elderly people who had undergone vitamin D 25-OH testing at the Rheumatology Outpatient Clinic in 2022.

Age, gender, serum vitamin D concentration, and recommendations for vitamin D administration provided to the patients were recorded. Vitamin D 25-OH concentration in patients' blood sera was measured via high performance liquid chromatography (HPLC). Vitamin D 25-OH classification was considered to be deficit when the concentration in the blood serum was <20 ng/mL, suboptimal level at >20-30, optimal level at >30-50, high level at >50-100, potentially toxic at >100-200, and toxic at >200 ng/mL [11].

The results obtained were analyzed using Statistica v.13.0 (StatSoft, Cracow, Poland). Mean values, standard deviation (SD) and 95% confidence interval (95% CI) were calculated. In order to compare hospitalized patients with those treated in the outpatient clinic, U Mann-Whitney test was performed. To compare HW, HM, OW and OM, a one-way analysis of variance was performed. In this study $p<0.05$ was considered statistically significant.

RESULTS

The average age of women from the Rheumatology Outpatient Clinic was 69.4 years (±SD 6.7; 95% CI 67-71) and men 69.9 (±8.1; 95% CI 66-73). The average age of women from the Geriatrics Ward was 83.6 (±7.2; 95% CI 81-85) and men 81.9 (±9.1; 95% CI 78-85).

In the hospitalised patients, mean vitamin D-25OH concentration in the blood sera was 23 ng/ml (±17, 95% CI 19-27) and in individuals treated in the outpatient clinic it was 25 ng/ml (±12; 95% CI 23-28).

Table 1. Vitamin D 25-OH concentration in outpatient women, outpatient men, hospitalized women, hospitalized men

	Outpatient Women (OW)	Outpatient Men (OM)	Hospitalized Women (HW)	Hospitalized Men (HM)
N	68	27	50	28
Mean vitamin D25-OH±SD [ng/ml]	26±1	22±3	26±23	19±13
p value	p<0.05 HM *vs* HW (ANOVA) and p<0.05 HM *vs* OW (ANOVA)			

one way analysis of variance (ANOVA)[ng/mL]

As many as 32% of all OW had vitamin D concentration <20 ng/mL, 36% had 20-30 ng/ml, 26% had 31-50 and 6% >50 ng/mL. Moreover, 55% of all OM had vitamin D concentration <20 ng/mL, 22% 20-30, 15% 31-50, and 8% had >50 ng/mL. In addition, 46% of all HW had vitamin D <20 ng/mL, 20% 20-30, 18% 31-50 and 16% >50 ng/mL and 67% of all HM had vitamin D <20 ng/mL, 13% 20-30, 20% 31-50, and none >50 ng/mL (Table 2). In total, 41% of all the outpatient elderly group and 55% of all the hospitalized had vitamin D concentration <20 ng/ml.

In the Outpatient Clinic, all the patients with vitamin D concentration in the blood serum <30 received prescriptions for cholecacliferol 20 000 IU to be administered orally twice a week after a morning meal and were instructed to come for a follow-up visit 2 months later. Out of 47 OW, 17 came for the follow up visit and their results were shown to have improved. In comparison, out of 21 OM meeting the same criteria, 100% returned, but their results were less satisfactory than in women (Table 3). All of them were advised to continue cholecalciferol at the dose of 2000 IU daily orally.

The hospitalized patients routinely received cholecalciferol 2000 IU orally daily after the morning meal. There was no follow-up in the hospitalized patients as some were transferred to another hospital, others were discharged home, and some died.

Table 2. Division of patients into groups according to the concentration of vitamin D 25-OH in the blood serum [ng/mL]

		Vitamin D-25-OH concentration [ng/mL]						
		N	Min	Me	Max	M	SD	95% CI
OW	<20 ng/mL	22	8	15	19	14	3.6	12-16
	20-30 ng/mL	25	20	24.8	29	24	2.7	23-26
	31-50 ng/mL	19	31	26	47	36	4.3	34-38
	>50 ng/mL	4	50	56	75	59	11.1	41-77
OM	<20 ng/mL	15	8	15	19	14.5	3.3	12-16
	20-30 ng/mL	6	22	24	29	24	2.5	22-27
	31-50 ng/mL	4	36	38	48	40	5.6	31-49
	>50 ng/mL	1	50	50	50	50	0.0	0-0
HW	<20 ng/mL	23	3	11	19	11	6.0	9-14
	20-30 ng/mL	10	20	26	29	25	3.5	22-27
	31-50 ng/mL	9	31	37	49	39	6.7	33-44
	>50 ng/mL	6	54	65	74	64	7.9	56-72
HM	<20 ng/mL	20	3	7	18	10	4.1	8-12
	20-30 ng/mL	4	21	22	25	99	1.9	19-26
	31-50 ng/mL	6	31	39	49	39	6.7	32-46
	>50 ng/mL	0	NA	NA	NA	NA	NA	NA

NA - not applicable

Hospitalized women (HW), hospitalized men (HM), outpatient women (OW), and outpatient men (OM)

Table 3. Vitamin D concentrations in the sera of patients from the Rheumatology Outpatient Clinic at the first and follow-up visit

	Vitamin D-25-OH concentration [ng/mL]			
	OW Initial visit	OW Follow-Up Visit	OM Initial Visit	OM Follow-Up Visit
N	17	17	11	11
Min	10	28	10	28
Me	17	37	15	32
Max	27	60	24	47
M	18	38	16	33
SD	5.8	8.9	4.8	5.8
95% CI	15-21	34-43	12-19	29-37
p value	p<0.05 OW Follow-Up Visit *vs* OW initial visit U Mann-Whitney test		p<0.05 OM Follow-Up Visit *vs* OM initial visit U Mann-Whitney test	

Outpatient women (OW); outpatient men (OM)

DISCUSSION

A limitation of this study was that comorbidities of the subjects were not examined, although this would certainly be of interest to readers. Data on age, gender and serum vitamin D level were obtained with the consent of the head of the Rheumatology Clinic in Bełzyce and the head of the Geriatrics Department in Lublin. Consent and analysis of other data were not obtained. The most common diagnoses in rheumatology clinics in Poland are polyarthritis (ICD10:M15), and in geriatric departments, it is anemia (D50). In accordance with the regulations, people over 16 years of age with joint diseases come to the rheumatology clinic, and people over 60 come to the geriatric department. Hence, there is a large difference in the average age between outpatients and hospitalized patients. Patients of the rheumatology outpatient clinics are able to walk and live at home. However, patients in geriatric wards are often bedridden at home or in a nursing home. Some live on their own, but most practice few outdoor activities.

In a study conducted in 2013 on a group of 5,775 volunteers in 22 cities in Poland, it was found that 64.9% of all women and 69.1% of all men had a vitamin D concentration <20 ng/ml, in total: 65.8% of all respondents [5]. The population analyzed in the quoted study was younger than ours. In our study, 32% of all OW had vitamin D concentration <20 ng/ml, 56% of all OM, 46% of all HW and 71% of all HM. In total, 46% of the analyzed group had vitamin D concentration <20 ng/ml. Our results are in agreement with the cited study in the aspect of sex differences: in general, women have higher concentration of vitamin D in the blood than men do.

The outpatients who adhered to physician's instructions in our study significantly increased their blood serum vitamin D concentration. Similar effects were obtained by Close, who conducted a study with 30 athletes and treated them with vitamin D. In his study, the test subjects were divided into 3 groups, that receiving for a period of 6 weeks: a placebo, 20,000IU vitamin D/week or 40,000 IU vitamin D/week. After 6 weeks, serum vitamin D 25-OH levels increased by an average of 79 nmol/L in participants taking 20,000 IU vitamin D and 98 nmol/L in participants taking vitamin D in a dose of 40,000 IU. All subjects taking 40,000 IU/week achieved normal levels of vitamin D after 6 weeks. Unfortunately, vitamin D did not improve the results of fitness tests [12].

Of interest, Romagnoli *et al*. conducted a prospective study with 32 elderly (aged 66-97 years) female nursing home residents in Italy. All the participants had vitamin D deficiency. The authors found that those patients who received cholecalciferol had twice as high concentration of serum 25(OH) vitamin D than those who received ergocalciferol [13]. In related work, Cipriani *et al*. conducted a differently designed prospective study concerning treatment with cholecalciferol. They recruited 48 free-living subjects (35 females and 13 males) aged 25-56 years (mean 36 years) with limited sun exposure because of poor tolerability, skin cancer or other skin diseases. At baseline, their blood serum vitamin D 25-OH level was 15.8±6.5 ng/mL. All participants received a single oral dose of 600,000 IU of cholecalciferol. Fasting blood samples were collected on day 3, 15 and 30 after cholecalciferol administration. A sharp and significant increase was observed already at day 3 ($p < 0.05$ *vs* baseline). Subsequently, there was a slow but not significant decrease until the end of the observation period [14].

In The United States (US) of America, the National Health and Nutrition Examination Survey (NHANES) provided data about serum vitamin D-25(OH) concentrations in the US population and its changes. Schleicher *et al*. compared the derived data concerning vitamin D blood serum level and supplementation from the years 2007-2010 and 2011-2014. In the study, vitamin D-25(OH) was measured in adults ≥20 years of age, and the authors observed that the unadjusted mean vitamin D-25(OH) increased by 2.7 nmol/L (95% CI: 0, 5.4 nmol/L). Moreover, the percentage of persons taking any vitamin D-containing supplements increased 2.9% (95% CI: 0.03, 5.5%). What is especially interesting is that the percentage of persons taking

supplements containing ≥1000 IU vitamin D/day increased 8.6% (95% CI: 6.9, 9.9). They also found that non-Hispanic blacks had vitamin D-25(OH) that was 22 nmol/L lower than that of non-Hispanic whites, and users of vitamin D-containing supplements ≥1000 IU/day had vitamin D-25(OH) 31 nmol/L higher than that of nonusers [15].

To our knowledge there was no former studies focusing on vitamin D 25-OH levels in hospitalized and outpatient elderly patients even though they are at the highest risk for falls, fractures and fragility syndrome.

Specialists in many fields of medicine see the benefits of its proper level in the blood. The pleiotropic effects of vitamin D include:

- increased disease resistance [16],
- reduced incidence of breast cancer [17] and colorectal cancer [18],
- improvement in the course of type 2 diabetes and accompanying metabolic disorders [19,20].

Vitamin D supplementation is especially important for elderly people to prevent osteoporotic bone fractures. However, a recent metaanalysis indicated that in young adults aged over 18 with metabolic syndrome, the evidence does not support the notion that vitamin D supplementation decreases triglyceride level and waist circumference [21]. Therefore, vitamin D should not be treated as a panacea.

CONCLUSIONS

In total 41% of all of the outpatient elderly and 55% of the hospitalized had vitamin D deficiency.

Treatment of vitamin D deficiency with cholecalciferol at a dose of 20,000 IU administered twice a week for two months is effective in outpatients.

Hospitalized patients with vitamin D deficiency should receive effective therapeutic doses of vitamin D and have a follow-up vitamin D test.

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