ORIGINAL ARTICLE

Prevalence of low serum vitamin D concentration in an urban population of elderly women in Poland

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KEY WORDS

deficiency, insufficiency, vitamin D

ABSTRACT

INTRODUCTION So far only scarce data have been published regarding serum vitamin D concentrations in elderly women in Poland.

OBJECTIVES We aimed to assess prevalence of vitamin D deficiency in a population of women aged 60 to 90 years and living in Warsaw.

PATIENTS AND METHODS The study comprised 274 women from the general population (mean age 69.1 ±5.7 years, body mass index [BMI] 28.9 ±4.6 kg/m^2, serum creatinine concentration 0.7 ±0.12 mg/dl). Subjects who had been treated with glucocorticoids or antifracture drugs, or supplemented with vitamin D or calcium, were excluded. The study was conducted in winter. Serum vitamin D, calcium, phosphate, and parathyroid hormone (PTH) concentrations were measured.

RESULTS The mean vitamin D concentration was 13.6 ng/ml in the whole examined population. Vitamin D levels above 30 ng/ml were detected in 4% of subjects. Vitamin D insufficiency (20–30 ng/ml) was found in 12.8% of subjects, and its deficiency (<20 ng/ml) in 83.2% of subjects. Vitamin D concentrations in women under and over 70 years of age did not differ significantly. There were no associations of vitamin D concentrations with age, BMI, renal function, or serum calcium concentrations. However, we observed a significant inverse correlation between vitamin D concentrations and PTH.

CONCLUSIONS The prevalence of low vitamin D concentrations in an urban population of elderly women in Poland is very high. Lower vitamin D levels are associated with a higher PTH concentration.

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INTRODUCTION As early as in 1822, a Polish scientist, Jędrzej Śniadecki, suggested that rickets in children may be related to inadequate sun exposure.[1] Now it is known that low sun exposure causes vitamin D deficiency, and that the latter is of much greater clinical importance than it was previously believed. It may cause not only rickets but may also lead to hypocalcemia and disturbances of bone metabolism, such as osteomalacia or osteoporosis, and increased fracture risk. Vitamin D deficiency may also play a role in the pathogenesis of autoimmune diabetes and other autoimmune diseases,[2] hypertension and other cardiovascular diseases,[3] cancer,[4] and psychiatric diorders.[5,6] Vitamin D deficiency could also increase mortality.[7] These and other consequences of vitamin D inadequacy may result in poorer public health.[8]

To assess vitamin D insufficiency or deficiency, serum 25(OH) vitamin D is measured, because the active hormone 1,25(OH)$_2$ vitamin D$_3$ has a short lifetime and its serum concentrations are low, which would make the assessment less reliable. Additionally, the measurement of serum 1,25(OH) vitamin D$_3$ concentration does not reflect vitamin D reserves in the body, as it may be normal even in patients with low vitamin D supplies.

Because vitamin D is produced in human skin from 7-dehydrocholesterol during sunlight exposure, serum vitamin D concentration depends on the season, being higher in summer and lower in winter. It may also depend on altitude (and insolation), diet, age, sex, skin color, type of clothes, urban or rural character of a country or region, and possibly other factors. The number of factors and their interrelations imply that any prediction of vitamin D status in populations for which no data are available may be elusive. Data on serum vitamin D concentration in the Polish population are scarce. The only available findings were derived from the MORE (Multiple Outcomes of Raloxifene Evaluation) study. The study showed that in 12.5% of women vitamin D concentration was lower than 25 nmol/l, and in 45.4% it was between 25 and 50 nmol/l.[9] Therefore, vitamin D deficiency was found in almost 60% of the examined women. However, the prevalence of vitamin D deficiency in this group may be falsely low because in elderly women with osteoporosis the proportion of subjects previously treated with vitamin D may be high.

In another study, which presented the data from Poland together with those from other European countries, deficiency or insufficiency of vitamin D was diagnosed in 90% of the population of adolescent girls. The number of examined subjects, however, was low.[10]

We aimed to assess vitamin D status in elderly women, not previously treated with vitamin D, who were the inhibitants of the city of Warsaw, Poland, and to determine factors associated with low vitamin D concentrations.

PATIENTS AND METHODS The study was conducted in a population of women aged 60 to 90 years. Subjects were randomly selected from the population of previously defined age, sex, and place of residency (Warsaw, Poland), based on the national identification number (*Powszechny Elektroniczny System Ewidencji Ludności* – PESEL) which covers the whole Polish population. We selected and invited 1200 women to participate in the study, and 456 subjects accepted the invitation. The study was approved by the local Ethics Committee. All participants had signed an informed consent; all procedures were conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000.

The study was conducted in winter, between December and March. A detailed medical history of each patient was taken. Blood specimen was obtained after overnight fasting from subjects who gave their consent. After centrifugation, serum and plasma were frozen in –20°C for later measurements. Serum samples for vitamin D determination was protected against sun exposure with black foil. A serum 25-hydroxyvitamin D concentration was assessed by a chemiluminescence immunoassay with standard kits (LIAISON®, DiaSorin Inc., Stillwater, United States; interassay precision 5%, intra-assay precision 7%). Parathyroid hormone (PTH) was determined using an electrochemiluminescence immunoassay, by an automated method on the Elecsys 2010 apparatus (Roche Diagnostics, Mannheim, Germany; intra-assay precision 1.5–4.1%, interassay precision 2.6–6.5%). Other biochemical parameters in blood were assessed using routine laboratory methods.

To obtain reliable results, we analyzed only those subjects from the whole group of 456 women, who had not been treated with either glucocorticoids or antifracture drugs, and who had not been supplemented with vitamin D or calcium. Subjects with chronic renal disease stage 3 or higher (glomerular filtration rate <60 ml/min as calculated by the Modification of Diet in Renal Disease equation), or with severe hepatic dysfunction were excluded.

Final statistical evaluation comprised 274 women. It was performed using STATISTICA software (StatSoft Inc., Tulsa, United States). Analysis of variance (Kruskall-Wallis ANOVA) was used primarily to compare data between age groups (life decades). Because of a small number of patients (11 only) in the 9th decade, those from the 8th and 9th decades were analyzed together using the Mann-Whitney test. Linear regression analysis was performed to assess independent

TABLE 1 Distribution of the examined parameters in particular life decades. Mean value ± standard deviation or median with minimal and maximal value are given. Significance of difference was assessed by the Mann-Whitney test.

	Group 1 age 60–69 years n = 149	Group 2 age 70–79 years n = 124	*P*
mean age (years)	64.9 ±3.0	73.3 ±2.7	<0.000001
height (m)	1.59 ±0.06	1.56 ±0.05	<0.00005
BMI (kg/m^2)	28.9 ±4.8	29.5 ±4.2	0.42
serum creatinine concentration (mg/dl)	0.69 ±0.12	0.75 ±0.16	<0.0005
serum calcium concentration (mg/dl)	9.0 ±0.5	8.9 ±0.6	<0.05
serum phosphate concentration (mg/dl)	3.3 ±0.4	3.3 ±0.4	0.21
PTH (pg/ml)	32.9 ±14.1	34.0 ±19.4	0.829
25-hydroxyvitamin D (ng/ml)	13.4 ±7.1	13.6 ±7.6	0.87

Abbreviations: BMI – body mass index, PTH – parathyroid hormone

TABLE 2 Associations between serum vitamin D concentration and listed variables – results of a linear regression analysis

Variable	β value	95% CI	*P*
age	0.02	–0.13; 0.17	0.83
BMI	–0.05	–0.20; 0.10	0.52
GFR (by Cockroft-Gault equation)	–0.01	–0.19; 0.17	0.89
serum calcium concentration	0.07	–0.05; 0.19	0.24
serum PTH concentration	–0.12	–0.24; 0.00	0.05

Abbreviations: CI – confidence interval, GFR – glomerular filtration rate, others – see TABLE 1

associations between vitamin D levels and age, body mass index (BMI), glomerular filtration rate, serum calcium and PTH concentrations.

RESULTS The final analysis comprised 274 women (mean age 69.3 ±5.7 years, BMI 29.0 ±4.7 kg/m^2, serum creatinine concentration 0.72 ±0.15 mg/dl). The subjects were in good general condition. Only 5.5% of the examined women suffered from diabetes mellitus, 20.4% from coronary heart disease, and 19.9% from heart failure. The most common condition (23.4% of the study population) was degenerative joint disease.

The population was divided into 2 groups: under and over 70 years of age. Their basal anthropometric and biochemical characteristics are presented in TABLE 1. Height and serum calcium concentration were significantly lower in the older group, while serum creatinine concentration was significantly higher. No significant differences were observed with regard to BMI, serum phosphate, PTH, and vitamin D concentrations.

Serum vitamin D concentrations in the examined population are shown in FIGURE 1. The mean serum concentration was 13.5 ng/ml. Desirable vitamin D levels, higher than 30 ng/ml, was detected only in 4.0% of subjects. Vitamin D deficiency (<20 ng/ml) was found in 83.2%, and vitamin D insufficiency (20–30 ng/ml) in 12.8% of subjects. Vitamin D concentration was similar in both groups of patients, as shown in TABLE 1.

A multiple linear regression analysis to evaluate independent associations of serum vitamin D concentration with age, BMI, calcium and PTH concentrations, kidney function, and statin use revealed a significant association only with PTH concentration (TABLE 2).

DISCUSSION Serum vitamin D concentration in the examined population was low. It was even lower than the mean concentration for 152 Polish women aged 65 years or older, who participated in the MORE study (55.2 nmol/l or approximately 21 ng/ml), and lower than the mean concentration for all Central-European women randomized in that study.[9] The difference may be caused by the fact that in our study the blood samples were taken in winter, while in the MORE study they were also collected in summer. Another possibility is that a number of patients screened and included in the MORE study had been treated with vitamin D before blood sampling. Such patients were excluded from our study. Therefore, the prevalence of vitamin D deficiency that has been shown in this study may more accurately reflect the actual value observed in the general population of elderly women in Poland.

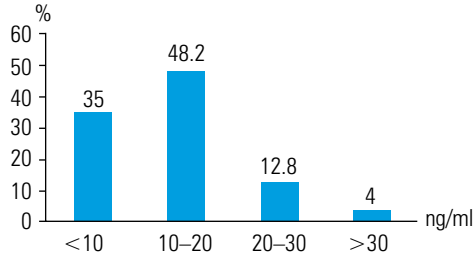

FIGURE 1 Prevalence of vitamin D deficiency, insufficiency, and adequacy in an urban population of elderly women in Poland

Poland did not take part in the SENECA study (Survey in Europe on Nutrition and the Elderly: a Concerted Action).[11] However, several European countries of similar latitude were involved, and blood samples were taken in winter. The median vitamin D concentration in the SENECA study was 33 nmol/l (approximately 12.5 ng/ml) and was very similar to the results observed in Poland. Other data originating from central and southern Europe show a high variability of the mean vitamin D level, with the lowest of about 10, and the highest of over 60 nmol/l.[12]

As can be seen in TABLE 1, vitamin D concentration was not related to age as opposed to other studies[13-15] whose authors have observed an inverse relationship between vitamin D and age. The difference may result from the fact that the mean vitamin D concentration in our study was very low even in a younger group, and therefore the expected decline might not have been noticed.

We have not found any relationship of vitamin D and weight or BMI, either, despite the fact that obesity is known to be associated with low vitamin D status.[16] The reason for this is probably similar to the above, namely low vitamin D concentration even in lean women have made the expected difference imperceptible. Additionally, in our population, the number of morbidly obese subjects, in whom a very low vitamin D concentration should be expected,[17] was small.

We have shown, however, a significant independent association between vitamin D and PTH concentrations (TABLE 2). Such a correlation was expected because vitamin D deficiency causes

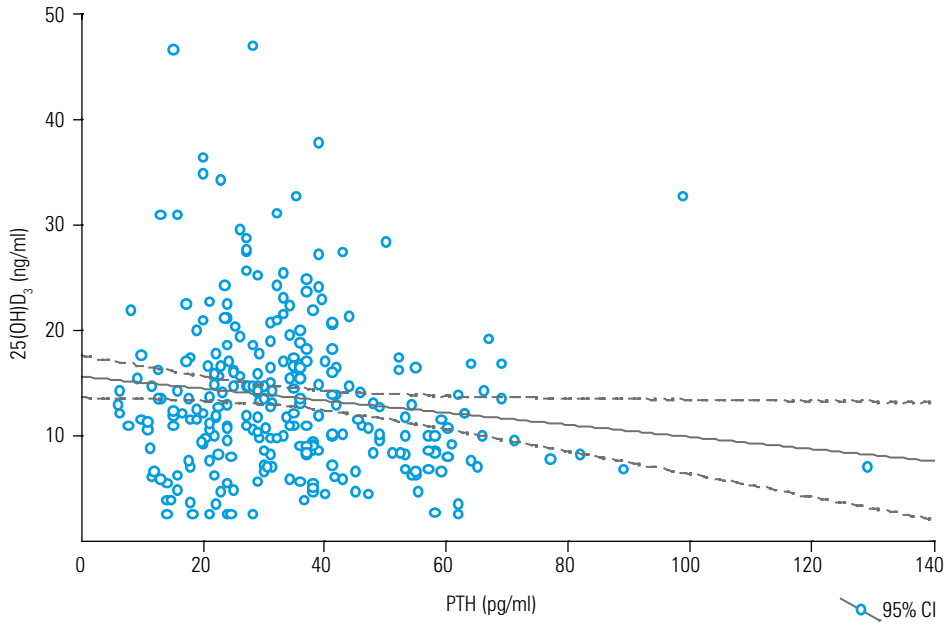

FIGURE 2 Correlation between serum vitamin D and parathyroid hormone concentrations ($r = 0.13$)
Abbreviations: see **TABLES 1** and **2**

a secondary hyperparathyroidism with increased PTH concentrations. However, it should be noted that the correlation was weak (**FIGURE 2**).

The main limitation of our study is the fact that the examined population did not fulfill criteria for representativeness of the population, because less than 50% of invited subjects took part in the study. However, this is the first study to examine vitamin D levels in patients with no vitamin D supplementation. Therefore, the prevalence of vitamin D deficiency observed in our study probably reflects the true figure for the general population more accurately than the results from studies on osteoporotic women. Additionally, our study population may represent the general population in Poland, because the population of Warsaw has changed considerably since the Second World War, mainly due to migration that occurred from other Polish urban and rural areas to the city.

The use of the LIAISON test, which assesses total 25-hydroxyvitamin D concentration (i.e., vitamins D_3 and D_2), is considered a strength of this study, as is the fact that all patients treated with vitamin D, even as a supplement, were excluded.

In conclusion, it can be stated that the prevalence of low vitamin D concentration in elderly women in Poland is very high. Lower vitamin D levels are associated with a higher PTH concentration.

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ARTYKUŁ ORYGINALNY

Częstość występowania małego stężenia witaminy D w surowicy starszych kobiet w Polsce

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SŁOWA KLUCZOWE

deficyt, niedobór, witamina D

STRESZCZENIE

WPROWADZENIE Dotychczas opublikowano niewiele danych dotyczących stężenia witaminy D w surowicy u starszych kobiet w Polsce.

CELE Celem niniejszego badania była ocena częstości występowania niedoborów witaminy D i czynników z nimi związanych w populacji kobiet w wieku 60–90 lat.

PACJENCI I METODY Do badania zakwalifikowano 274 kobiety wybrane losowo z populacji ogólnej (średni wiek 69,1 ±5,7 lat, wskaźnik masy ciała [*body mass index* – BMI] 28,9 ±4,6 kg/m^2, stężenie kreatyniny w surowicy 0,7 ±0,12 mg/dl), nieleczonych glikokortykoidami, bisfosfonianami lub innymi lekami przeciwzłamaniowymi, nieotrzymujących suplementacji witaminą D ani wapniem. Badanie było przeprowadzone w miesiącach zimowych. Oceniano stężenie witaminy D w surowicy oraz czynniki potencjalnie mogące być związane z jej niedoborem.

WYNIKI Średnie stężenie witaminy D w surowicy w badanej populacji wynosiło 13,6 ng/ml. Stężenie >30 ng/ml stwierdzono u 4% badanych kobiet. Niedobór witaminy D (20–30 ng/ml) stwierdzono u 12,8%, a deficyt (stężenie <20 ng/ml) u 83,2% badanych. Stężenie witaminy D w surowicy nie różniło się znamiennie u kobiet poniżej i powyżej 70 roku życia. Nie stwierdzono znamiennych korelacji z wiekiem, BMI, czynnością nerek ani stężeniem wapnia w surowicy. Jednakże stwierdzono odwrotną korelację pomiędzy stężeniem witaminy D i parathormonu.

WNIOSKI Częstość występowania niedoborów witaminy D u starszych kobiet w Polsce jest bardzo duża. Małe stężenia witaminy D korelowały ze zwiększonymi stężeniami parathormonu.

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