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Prevalence of hypovitaminosis D in institutionalized elderly

Prevalência de hipovitaminose D em idosos institucionalizados

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Abstract

Vitamin D deficiency affects approximately one billion people around the world, making it a public health problem. It causes changes in growth and bone development in children and osteomalacia and osteoporosis in adults and elderly. Vitamin D makes possible normal bone mineralization and bone calcium mobilization into the blood. The deficiency of it increases the risk of falls in the elderly and, consequently, the risk of fractures and/or other health problems. Considering the information presented, the prospective cross-sectional study with probability sampling, aimed to determine the prevalence of hypovitaminosis D in institutionalized elderly in Passo Fundo/RS. 77 elderly patients participated in the study. The levels of 25-hydroxyvitamin D were measured and were associated with the socioeconomic and demographic data, medication and daily habits. The data were collected between June to August 2011. There was a prevalence of hypovitaminosis D among 97% of the sample. A noticeable deficiency of vitamin D was only statistically associated with albumin levels (p = 0.048). It was also evident that there was a negative correlation between the serum levels of 25 (OH) D and the parathyroid hormone PTH (rs = -0.240, p = 0.033). There is a high prevalence of hypovitaminosis D among institutionalized elderly. Health professionals and caregivers should take interdisciplinary measures that minimize this public health problem.

Keywords: Epidemiology. Vitamin D. Elderly health.

Resumo

A insuficiência de vitamina D acomete aproximadamente 1 bilhão de pessoas no mundo, tornando-se um problema de saúde pública. Ela causa alterações no crescimento e desenvolvimento ósseo em crianças e osteomalácia e osteoporose em adultos e idosos. A vitamina D permite a mineralização óssea normal e mobiliza cálcio do osso para o sangue. Sua deficiência aumenta o risco de quedas na velhice e, consequentemente, o risco de fraturas e/ou outros problemas de saúde. Considerando as informações apresentadas, o estudo transversal prospectivo, com amostragem probabilística, teve como objetivo avaliar a prevalência de hipovitaminose D em idosos institucionalizados em Passo Fundo/RS. Participaram do estudo 77 idosos. Mediram-se os níveis de 25-hidroxivitamina D, relacionando-os com dados socioeconômicos e demográficos, medicamentos e hábitos diários. Os dados foram coletados entre os meses de junho a agosto de 2011. Houve prevalência de hipovitaminose D em 97% da amostra estudada. A deficiência acentuada de vitamina D esteve apenas associada estatisticamente com os níveis de albumina (p = 0,048). Evidenciou-se correlação negativa entre os níveis séricos de 25(OH)D e PTH (rs = -0,240, p = 0,033). Evidencia-se alta prevalência de hipovitaminose D na população idosa institucionalizada. Os profissionais de saúde e cuidadores devem tomar medidas de caráter interdisciplinar que minimizem esse problema de saúde pública.

Palavras-chave: Epidemiologia. Vitamina D. Saúde do idoso.

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INTRODUCTION

Vitamin D is considered a hormone produced in human skin through the action of sun rays, but it can also be acquired through the intake of fish or supplementation, being that few natural foods contain it.[1] Vitamin D undergoes two metabolic processes. In the liver, it is transformed into 25-hydroxyvitamin D (25(OH) D), whose serum values are used to assess sufficiency; shortly thereafter, in the kidney, it is transformed into its active metabolite, 1,25-dihydroxyvitamin D (1,25(OH)2D). Its main function is to intervene in phosphocalcic metabolism by increasing serum calcium levels by absorption of calcium in the intestine through binding to specific receptors and by modulation of osteoclastogenesis.[2]

The elderly population is known to be deficient in vitamin D, and multiple factors may be involved, such as a lack of sun exposure, inadequate diet, intestinal malabsorption, reduced renal production of 1,25(OH)2D, and reduced cutaneous efficiency in producing vitamin D.[1] The institutionalized elderly also have a higher risk of hypovitaminosis D compared to the outpatient clinic, because they expose themselves less to the sun and use more medications that may interfere with their metabolism.[3] Since this risk is greater in institutionalized settings, a routine measurement of 25(OH)D in this population is recommended.[4]

There is evidence that the positive association between vitamin D levels and mineral density in the femoral neck promotes greater bone strength. As a result, a lower frequency of fractures occurs, therefore vitamin D supplementation has been reported. Within this context, a question is raised: what is the prevalence of hypovitaminosis D in the elderly living in LSIE's in the city of Passo Fundo? To answer this question, the objective of the study was to evaluate serum levels of vitamin D in institutionalized elderly.

MATERIALS AND METHODS

Cross-sectional study carried out in eleven long-stay institutions for the elderly (LSIE's) of the city of Passo Fundo, RS. The individual residents were randomly selected among those comprising the resident elderly population (n = 305). The eleven institutions were selected for convenience. The data were collected between the months of June and August of 2011.

77 elderly people participated in the study. The sample size for hypovitaminosis D in the institutionalized elderly in LSIE's was defined by a 95% confidence interval with a sampling error of 5%. The inclusion criteria were to be over 60 years old and to have resided in the LSIE for more than three months. Excluded from the study were the those with communication problems, suggestive of severe cognitive deficits or with aphasia due to stroke; impaired motor skills associated with advanced stage and terminal diseases; hearing and/or visual deficits that made communication difficult. Those who refused to participate or did not meet the inclusion criteria were replaced by the next individual drawn, successively.

A questionnaire was applied that analyzed the following variables: age, gender, color, schooling, time in months and cost of institutionalization, frequency of fish intake in the previous week, presence of comorbidities associated with hypovitaminosis D, continuous use of medication, use of vitamin D supplementation, time of sun exposure and degree of ambulation.

BMI was classified as low weight up to 22 kg/m^2; as eutrophy between 22 and 27 kg/m^2; and as overweight above 27 kg/m^2. Blood was collected during fasting (for at least eight hours) in the morning for measuring serum calcium, albumin, creatinine, PTH, and 25(OH)D. The assessment of the glomerular filtration rate was performed using endogenous creatinine clearance (ECD). The subjects were categorized according to serum levels of vitamin D (25(OH) D) in ng/mL, in: (1) sufficient (≥ 30), (2) insufficient (> 20 and <30), (3) deficient (≥ 10 and ≤ 20) and (4) severe deficiency (<10).[2,3]

Data were entered and analyzed in SPSS, version 23.0. Tests were considered significant with $p \leq 0.05$. The study was submitted to the Research Ethics Committee of the University of Passo Fundo, through the authorization of the directors of the LSIE's, and was approved by Proposal 130/2010.

RESULTS

The mean age was 78.8 ± 10.2 years old. The median institutionalization time was 24.0 [12.0; 48.0] months; regarding characteristics, 49 (63.6%) were female and only two (2.6%) were black; 36 (46.8%) presented low body mass index BMI (Kg/m²); the mean BMI was 23.7 ± 3.9 kg/m² (Table 1).

As for the habits that can influence serum levels of vitamin D; supplements were used by nine elderly people (11.7%); 58 (75.3%) reported sunbathing on the face and arms for at least 15 minutes three times a week; 22 (28.6%) reported eating fish one to three times a week, and eight (10.4%) used sunscreen (Table 2).

The median number of medications used in the last three months was 4.0 [2.0; 6.5] medicines; thirty-six elderly subjects (46.8%) were in continuous use of drugs, with 15 (19.5%) anticonvulsants, one (1.3%) with corticosteroids and twenty (26.0%) with diuretics. The prevalence of hypovitaminosis D was 97% ([94%, 100%], 95% CI), considering the level of 30 ng/mL or more as sufficient. The median of serum vitamin D was 7.9 ng/mL [4.7; 12.4]; two (2.6% ± 3.6%) individuals were classified as sufficient; six (7.8% ± 6.0%) as insufficient; 19 (24.7% ± 9.6%) as deficient, and 50 (64.9% ± 10.7) as markedly deficient. To identify groups more subject to marked deficiency, the association between marked deficiency and sociodemographic characteristics and biochemical markers were tested (Table 3).

There was no statistically significant association between severe hypovitaminosis D, age (p = 0.280), institutionalization time (p = 0.390) and BMI (p = 0.334). Serum albumin, measured in g/dL, was statistically lower among subjects with severe hypovitaminosis D compared to the others, (3.5 ± 0.4 g/dL vs 3.7 ± 0.1 g dL respectively, p = 0.048), which was not observed in relation to calcium, DCE and PTH values. Hyperparathyroidism was observed in 25 (32.5%) of the individuals, all of which were classified as secondary and also inversely correlated between serum levels of vitamin D and PTH (rs = -0.240, p = 0.033) (Figure 1).

The association between severe deficiency and socio-demographic characteristics, habits that influence serum vitamin D levels, and biochemical markers were also tested to identify the groups more susceptible to severe deficiency (Table 4).

There was no statistically significant association between severe hypovitaminosis D, sex (p = 0.279) and color (p = 0.677). There was no statistically significant association between severe vitamin D deficiency and vitamin D supplementation (p = 0.712), sun exposure (p = 0.714), fish intake (p = 0.706) and use of sunscreen (p = 0.350).

Although not statistically significant, the prevalence of severe hypovitaminosis D was lower among individuals who walked independently than those who had restrictions on walking (58.0% vs 78.8% | p = 0.083). Continuous use of diuretics (p = 0.994) and endogenous creatinine clearance (p = 0.460) were also not significantly associated with severe hypovitaminosis D.

Table 1 – The sociological and demographic characteristics of a sample (n = 77) of institutionalized elderly. Passo Fundo, RS, 2012.

Variable	Measurements
Average age (years)	78.8 ± 10.2
Time of institutionalization (months)	24.0 [12.0; 48.0]
Sex	
Female	49 (63.6%)
Male	28 (36.4%)
Color	
White	68 (88.3%)
Brown	7 (9.1%)
Black	2 (2.6%)
Body Mass Index - BMI (Kg/m²)	
Underweight	36 (46.8%)
Eutrophy	20 (26.0%)
Overweight	4 (5.2%)

Mean ± standard deviation; Median [P25; P75]

Table 2 – Characteristics that influence serum levels of vitamin D in a sample (n = 77) of institutionalized elderly. Passo Fundo, RS, 2012.

Variable	n (5)
Vitamin D supplementation (No)	68 (88.3%)
Sun exposure (Yes)	58 (75.3%)
Fish intake (No)	55 (71.4%)
Sunscreen (No)	69 (89.6%)
Ambulation (Independent)	50 (64.9%)

Table 3 – Associations between severe hypovitaminosis D and sociodemographic characteristics and biochemical markers. Passo Fundo, RS, 2012.

Variable	Severe dificiency of vitamin D		Valor p
	No (n = 27)	Yes (n = 50)	
Age (years)	77.0 ± 9.7	79.7 ± 10.4	0.280
Time of institutionalization	42.0 [15.0; 64.0]	21.5 [9.0; 39.3]	0.390
BMI (Kg/m²)	24.3 ± 3.9	23.3 ± 4.0	0.334
Corrected Calcium (mEq/L)	5.0 ± 0.5	5.0 ± 0.4	0.985
ECD (endogenous creatinine clearance)	49.8 ± 16.2	45.9 ± 15.9	0.360
PTH (pg/mL)	34.0 [25.5; 70.5]	45.0 [35.0; 66.0]	0.255
Albumin (g/dL)	3.7 ± 0.1	3.5 ± 0.4	0.048

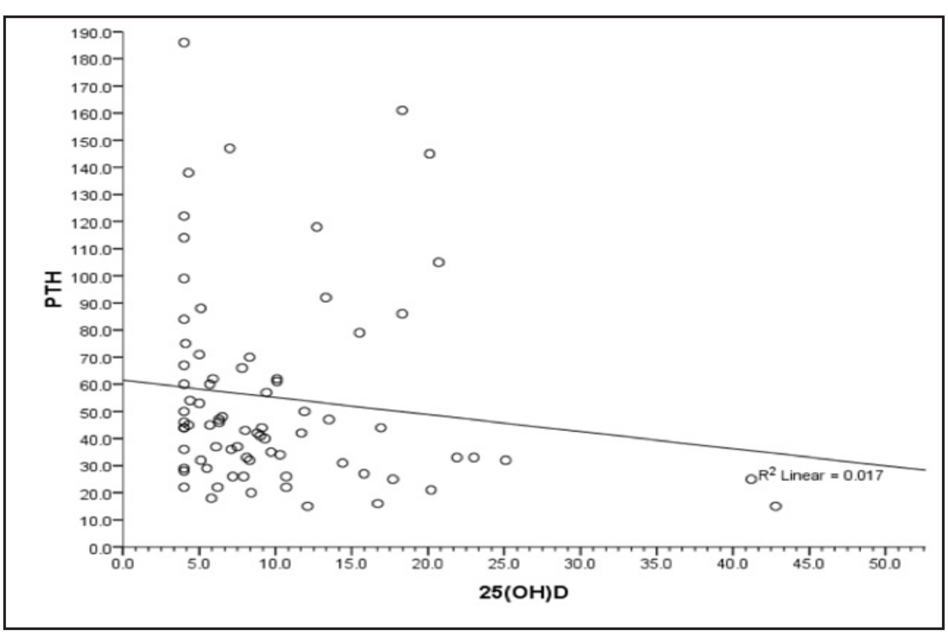

Figure 1 – Correlation between 25(OH)D and PTH levels. R2 Linear = 0,017; Passo Fundo, RS, 2012.

Table 4 – Associations between severe hypovitaminosis D, sociological and demographic characteristics, habits that influence serum levels of Vitamin D, and biochemical markers. Passo Fundo, RS, 2012.

Variable	Severe Vitamin D dificiency		Valor p
	No (n = 27)	Yes (n = 50)	
Sex			
Female	15 (30.6%)	34 (69.4%)	0.279
Male	12 (42.9%)	16 (57.1%)	
Color			
White	25 (36.8%)	43 (63.2%)	0.667
Brown	2 (28.6%)	5 (71.4%)	
Vitamin D supplementation			
No	23 (33.8%)	45 (66.2%)	0.712
Yes	4 (44.4%)	5 (55.6%)	
Sun			
No	6 (31.6%)	13 (68.4%)	0.714
Yes	21 (36.2%)	37 (63.8%)	
Fish			
No	20 (36.4%)	35 (63.6%)	0.706
Yes	7 (31.8%)	15 (68.2%)	
Sunscreen			
No	23 (33.3%)	46 (66.7%)	0.350
Yes	4 (50.0%)	4 (50.0%)	
Ambulation			
Independent	21 (42.0%)	29 (58.0%)	0.083
Dependent	6 (22.2%)	21 (77.8%)	
Diuretic			
No	20 (35.1%)	37 (64.9%)	0.994
Yes	7 (35.0%)	13 (65.0%)	
ECD (endogenous creatinine clearance)			
No	27 (35.5%)	49 (64.5%)	0.460
Yes	0 (0%)	1 (100%)	

Pearson's Chi-square test and Fisher's exact test; Significant values for a $p \leq 0.05$.

DISCUSSION

In the present study, the prevalence of hypovitaminosis D, defined as 25(OH)D levels less than 30 ng/mL, was 97% in the sample studied in August and November 2010 (winter and spring in the southern hemisphere). Levels of sufficiency were found in only 2.6% of the sample; of insufficiency in 7.8%; of deficiency in 24.7%; and there was severe deficiency of vitamin D in 64.9% of the subjects. Only 11.7% of the subjects used vitamin supplementation. In other studies that investigated hypovitaminosis D in institutionalized elderly patients, similar values were found. There is an estimated prevalence ranging from 25 to more than 80%.[5]

The statistically significant inverse correlation between vitamin D and PTH levels found in this study has been documented in others, including in non-elderly populations. In one study, up to 75% of this population could be found in this situation, which is known as functional hypoparathyroidism and has no definite cause.[6] Considering the maximum normal limit for PTH being 53 pg/mL, another study characterized lower 25(OH)VD values among patients with PTH above the reference value.[7]

The habits such as sun exposure, vitamin D supplementation and fish consumption that may improve serum vitamin D levels were verified in this study. In some studies referring to sun exposure it can be observed that the analyzed parameters possessed a significant difference between the concentrations of 25OHD between the photoexposed group and the photoprotected group.[8] In the case of those who reported being exposed to the sun for at least 30 minutes per day, there was no significant relationship of exposure time with 25-hydroxyvitamin D levels in the elderly groups with adequate and inadequate levels of the vitamin.[9] In subjects taking vitamin D supplements, there were no cases of vitamin D deficiency [25(OH)VD below 14 ng/mL], but 27% found insufficient levels of vitamin D [25(OH)VD below 32 ng/mL]. Individuals with a larger consumption of fish, was positively associated with higher serum levels of vitamin D ($p = 0.006$).[10]

When the present study compared the level of ambulation between the "deficient, insufficient or sufficient" groups and "severe deficiency", there was a tendency to develop hypovitaminosis. among those who walked with limitations. This finding resembles that of the study of institutionalized subjects in Wisconsin, USA, which found significantly lower levels of vitamin D in the elderly with less mobility, suggesting that this correlation could be due to the lesser sun exposure imposed by the physical difficulty.[11]

Although not evaluated in the present study, the relationship of vitamin D deficiency, ambulation and muscle strength can be made, since vitamin D deficiency has the potential to compromise muscle strength and this could interfere with the process of ambulation. Such a finding could be explained by the relationship of vitamin D deficiency with changes in muscle strength and impact on ambulation.

The results presented in a systematic review on the role of vitamin D in skeletal muscle showed that myopathy or muscle weakness is a characteristic described in vitamin D deficient conditions and include histological changes, like atrophy of type 2 fibers, which are responsible for explosive and fast movements, and are recruited to prevent a fall.[12] The studies evaluated by them demonstrate that supplementation improves muscle strength and performance by increasing muscle mass and increasing muscle fibers. Some studies suggest that calcium also participates in this muscle function and not exclusively active vitamin D, and that this mechanism is not yet fully elucidated because there are many controversies about the role of vitamin D in the adult muscle.[13] This can be observed in a meta-analysis of 26 randomized studies with vitamin D supplementation where they found a statistical decrease in the risk of falls in patients with vitamin D deficiency ($p \leq 0.05$); interestingly, this effect was only observed in studies that used concomitant use of vitamin D + calcium.[14]

It was observed that individuals with severe vitamin D deficiency had significantly lower serum albumin levels than the other subjects. Albumin levels fall with aging, and this protein, along with vitamin D binding protein, is responsible for transporting vitamin D into the blood. A study with frail, Japanese elderly subjects describes a direct correlation between levels of 25-hydroxyvitamin D and serum albumin and that albumin concentration is important to maintain vitamin D concentration. It is emphasized that vitamin D deficiency and protein deficiency in the institutionalized elderly is common. According to the study, the association of these with the lack of sun exposure may increase the risk of fractures by increasing bone loss and the propensity for falls.[16]

In addition to this, recent studies have shown that vitamin D deficiency is related to other pathologies such as cancer, diabetes melittus[17] and cardiovascular processes, such as hypertension and atherosclerosis.[18] Observational studies demonstrate such associations, but interventional studies, for the most part, fail to demonstrate the benefit of reducing such outcomes. In view of this, it is postulated that hypovitaminosis D is associated with these diseases as a risk indicator, yet there is no scientific evidence to support it as a risk factor. When discussing the probability that the results found in observational studies were due to causality it was suggested that hypovitaminosis D was not the cause. It was argued that it could be a consequence of disease or an association of problems arising from frailty.[19,20,21]

The results showed that the prevalence of hypovitaminosis D in the study group was 97%, considering the level of 30 ng/mL or more as sufficient. It should be noted that the present study has limitations. This is a cross-sectional study, with a small number of subjects evaluated, besides the collection period having occurred in the months of lower solar radiation. Longitudinal studies with larger populations are suggested. This would allow to broaden the knowledge about the subject, being able to support the actions and strategies, in order to ensure a better monitoring of the levels of vitamin D and reducing the possible comorbidities.

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Longitudinal studies with larger populations are suggested. This would allow to broaden the knowledge about the subject, being able to support the actions and strategies, in order to ensure a better monitoring of the levels of vitamin D and reducing the possible comorbidities.

CONCLUSION

There is a high prevalence of hypovitaminosis D in the institutionalized elderly population. Serum albumin was statistically lower among subjects with severe hypovitaminosis D. The results indicate a negative correlation between serum levels of vitamin D (25(OH)D) and parathyroid hormone (PTH). In view of the results of the study, health professionals and caregivers should take interdisciplinary measures that minimize this public health problem.

REFERENCES

1. Holick MF. High prevalence of vitamin D inadequacy and implications for health. Mayo Clinic Proceedings. 2007a; 81(3):353-73.
2. Holick MF. Vitamin D: its role in cancer prevention and treatment. Progress in Biophysics and Molecular Biology. 2007b; 92(1): 49-59.
3. Pearse SHS, Cheetham TD. Diagnosis and management of vitamin D deficiency. British Medical J. 2010; 340: 142-7.
4. Saraiva GL, Cendoroglo MS, Ramos LR, Araújo LMQ, Vieira JGH, et al. Prevalência da deficiência, insuficiência de vitamina D e hiperparatiroidismo secundário em idosos institucionalizados e moradores na comunidade da cidade de São Paulo, Brasil. Arq Bras Endocrinol Metab. 2007; 51(3):437-42.
5. Ramel A, Josson PV, Bjornsson S, Thorsdottir I. Vitamin D deficiency and nutritional status in elderly hospitalized subjects in Iceland. Public Health Nutr. 2009; 12(7): 1001-5.
6. Chen JS, Sambrook PN, March L, Cameron ID, Cumming RG, Simpson JM, Seibel MJ. Hypovitaminosis D and parathyroid hormone response in the elderly: effects on bone turnover and mortality. Clin Endocrinol. 2008; 68(2):290-8.
7. Silva BCC, Camargos BM, Fujji JB, Borges J, Dias EP; Soares MMS. Prevalência de deficiência e insuficiência de vitamina d e sua correlação com pth, marcadores de remodelação óssea e densidade mineral óssea, em pacientes ambulatoriais. Arq Bras Endrocrinol Metab. 2008; 52(8): 482-8.
8. Maia M, Maeda S S, Maçon C. Correlação entre fotoproteção e concentrações de 25 hidroxi-vitamina D e paratormônio. An Bras Dermatol. 2007; 82(3): 233-7.
9. Neves JPR, Silva AS, Morais LCSL, Diniz AS, Costa MJC, Asciutti LSR, Gonçalves MCR. Concentrações de 25-hidroxivitamina D e níveis pressóricos em idosos hipertensos. Arq Bras Endocrinol Metab. 2012: 56(7):415-22.
10. Lima, PLV, Almeida GBC, Bella LM, Bastos AN, Bonfante HLM, Bonfante HL. Hipovitaminose D em idosos institucionalizados tratados com anticonvulsivantes, uma associação freqüente. Rev Psiq Clín. 2012; 39(5): 172-5.
11. Drinka PJ, Krauze PF, Nest LJ, Goodman BM. Determinants de vitamin D levels in nursing home residents. J Am Med Assoc. 2007; 8(2): 76-9.
12. Ceglia L. Vitamin D and Its Role in Skeletal Muscle. Curr Opin Clin Nutr Metab Care. 2009; 12(6): 628-33.
13. Rosen CJ, Adams JS, Bikle DD, Black DM, Demay MB, Manson JE, et al. The nonskeletal effects of vitamin D: an Endocrine Society scientific statement. Endocrine Reviews. 2012; 33(3): 456-92.
14. Murad MH, Elamin KB, Abu Elnour NO, Elamin MB, Alkatib A a, Fatourechi MM, et al. Clinical review: The effect of vitamin D on falls: a systematic review and meta-analysis. J Clin Endocrinol Metab. 2011; 96(10): 2997–3006.
15. Nakamura K, Ueno TNK, Yamamoto M. Age-related decrease in serum 25-hydroxyvitamin D concentrations in the frail elderly: a longitudinal study. J Bone and Miner Metab. 2007; 25(4):232-6.
16. Bonjour JP, Benoit V, Pourchaire O, Rousseau B, Souberbielle JC. Nutritional approach for inhibiting bone resorption in institutionalized elderly women with vitamin d insufficiency and high prevalence of fracture. J Nutr Health Aging. 2011; 15: 404-9.
17. Schuch NJ, Garcia VC. Vitamina D e doenças endocrinometabólicas. Arq Bras Endocrol Metab. 2009; 53(5): 625–33.
18. Motiwala SR, Wang TJ. Vitamin D and cardiovascular risk. Curr Hypertens Rep. 2012; 14:209–18.
19. Theodoratou E, Tzoulaki I, Zgaga L, Ioannidis JPA. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomized trials. BMJ. 2014; 348: g2035.
20. Bolland MJ, Grey A, Gamble GD. The effect of vitamin D supplementation on skeletal, vascular, or cancer outcomes: a trial sequential meta-analysis. The Lancet. 2014; 2(4):307-20.
21. Autier P, Boniol M, Pizot C, Mullie P. Vitamin D status and ill health: a systematic review. The lancet. 2012; 2(1): 76-89.

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