Assessment of vitamin D status in different samples of an elderly Egyptian population

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Introduction
Vitamin D is one of the important hormones involved in Ca homeostasis. It is also essential for the prevention of osteoporosis and fractures. Vitamin D is important for maintaining many physiologic functions, such as optimal balance, muscle strength, and innate immunity. Vitamin D deficiency is associated with an increased risk for several types of cancer, as well as autoimmune and cardiovascular disorders. As the influence of diet on vitamin D status is minimal and most circulating vitamin D is derived from exposure to sunlight, elderly populations are greatly affected; they have marked limitations that hinder their exposure to sunlight as well as their feeding and nutritional habits.
Objectives of the study
The aim of this study was to assess vitamin D status in Egyptian geriatric, homebound, nursing home residents, and ambulatory elderly individuals.
Patients and methods
This study was carried out on 90 elderly male and female individuals divided into three groups: the first group included 30 homebound elderly individuals, the second group included 30 elderly individuals living in nursing homes, and the third group included 30 community-dwelling ambulatory elderly individuals.
Results
There were high statistically significant difference in the vitamin D levels between the groups studied, being the highest in group III, 158 (18–240) nmol/l, and the lowest in group II, 16 (4–194) nmol/l. Statistically significant differences were found in sun exposure, with good exposure in 60% of the individuals in group III. There were also statistically significant differences in the intake of vitamin D in diet, with good intake in 64.30% of the individuals in group III. Also, we found the highest waist circumference in group II (98.68±20.73 cm). Vitamin D showed a significant positive correlation with serum calcium in group II (ρ=0.199) and a positive correlation with aspartate transaminase (AST) in group III (ρ=0.418).
Conclusion
Elderly Egyptian individuals in nursing houses are at risk of developing vitamin D deficiency because of lack of exposure to sunlight, dietary problems, and or central obesity.

Keywords:
elderly, nutritional state, sun exposure, vitamin D

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Introduction

Vitamin D deficiency is a global health problem. With all the medical advances of the century, vitamin D deficiency is still highly prevalent. Over a billion individuals worldwide are vitamin D deficient or insufficient [1]. Yet, no international health organization or governmental body has declared a health emergency to warn the public about the urgent need to achieve sufficient vitamin D blood levels in the elderly. Vitamin D is a hormone precursor that is present in two forms: ergocalciferol (vitamin D2) in plants and some fish and cholecalciferol (vitamin D3) synthesized in the skin by sunlight. Humans can meet their vitamin D requirements by ingesting vitamin D or being exposed to the sun for a sufficient amount of time [2]. The liver readily hydroxylates vitamin D into 25-hydroxy-vitamin D [25(OH)D], the circulating form of vitamin D [3]. Further hydroxylation of 25(OH)D occurs, mostly in the kidney, into 1,25-dihydroxy-vitamin D [1,25(OH)2D], acting principally on the duodenum to increase calcium absorption [4]. The enzyme that hydroxylates 25(OH)D is present in a wide variety of human tissues other than the kidney. 1,25(OH)2D is autonomously present in tissues and directly affects numerous cells through its autocrine and paracrine functions [5]. Most organs show evidence of end-organ responsiveness to 1,25(OH)2D. Like all steroid hormones, 1,25(OH)2D acts as a molecular switch, activating more than 200 target genes, thereby regulating gene expression [6]. Circulating 1,25(OH)2D enters the target cell, in its free form, and binds to the vitamin D receptor (VDR) in the cytoplasm, which then translocates to the nucleus and heterodimerizes with the retinoic×receptor [7]. The 1,25(OH)2D-VDR-retinoic×receptor complex then binds to vitamin D response elements on DNA to increase the transcription of vitamin D-regulated genes. VDRs are found in the classic target organs: gut, bone, kidney, and parathyroid and many other tissues as well such as the brain, breast, colon, heart, pancreas, prostate, skin, and immune system [8].

Classic functions regulated by vitamin D include genes important for mineralization of bone and calcium transport in the intestine [9]. Nonclassic functions of vitamin D under investigation include genes important for innate immunity, cancer proliferation, muscle (both skeletal and smooth) function, and endothelial cell proliferation [10].

According to the center for disease control and complication trial, maintaining enough calcium and vitamin D level is a step to prevent osteoporosis, which is the most common cause of falls and fall-related injuries in seniors as falls are the leading cause of injury death in adults aged 65 years and older [11]. Vitamin D deficiency is associated with fatigue, muscle weakness, increase in falls, and secondary hyperparathyroidism, which leads to cortical bone loss [12]. Also, there is an increased risk for several types of cancers, as well as autoimmune and cardiovascular disorders [13,14].

Inadequate vitamin D intake, urban dwelling, female sex, wearing the veil, winter season, age, and high parity were independent predictors of low vitamin D levels [14,15].

Our aim is to evaluate the status of vitamin D in geriatric Homebound, nursing home residents, and ambulatory Elderly individuals and to correlate its deficiency to several related factors to establish a nationally certified program to the exposed group halting insufficiency related complications.

Patients and methods

This study was carried out on 90 elderly men and women aged between 60 and 75 years from Ain Shams University Hospital, from among homebound, ambulatory relatives, and other nursing home residents after obtaining written consent during the period from July 2015 to December 2015. They were divided into three groups:

Group I: 30 homebound elderly cases, 18 women, 10 of whom wore veils, and 12 men with a mean age of 68.21±5.32 years.

Group II: 30 elderly individuals living in nursing homes, 13 women, nine of whom wore veils, and 17 men with a mean age of 65±5.07 years.

Group III: 30 community-dwelling ambulatory elderly individuals, 16 women, seven of whom wore veils, and 14 men with a mean age of 68.32±5.33 years.

All participants were subjected to the following:

(1) Assessment of history: Full medical history (DM, Hypertension, cardiovascular diseases, bone fractures, presence of any psychological or cognitive disorders, history of drug intake). Nutritional history with a special focus on calcium and vitamin D intake, classifying them into individuals with average nutrition, receiving a vitamin D-rich diet once or twice/week, moderate nutrition, with a vitamin D-rich diet once/2 week, and little nutrition, with a vitamin D-rich diet only once/month [16]. Time of sun exposure was calculated and participants were divided into those who received good sun exposure (10–15 min/day), little sun exposure (<10 min/day), or no sun exposure according to the sun exposure index [10].
(2) Clinical examination: blood pressure was measured, along with BMI and waist circumference, with cut-off points for abdominal obesity of more than 88 cm in women and more than 102 cm in men, measured using a standardized tape.
(3) Laboratory investigation: complete blood count, AST, alanine transaminase (ALT), serum creatinine, serum calcium, and phosphorus, serum alkaline phosphatase, and serum 25-hydroxyl-vitamin D were determined using an immune diagnostic enzyme-immunoassay for the quantitative determination of the 25(OH)D in plasma and serum. A competitive protein-binding assay for the measurement of 25(OH)D is based on the competition of 25(OH)D present in the sample with a 25(OH)D tracer for the binding pocket of vitamin D binding protein [17].

Expected values

The expected values are as follows: deficiency (<30 nmol/l) (<12 ng/ml), insufficiency (30–75 nmol/l)

(12–30 ng/ml), and sufficiency (>75 nmol/l) (>30 ng/ml) [18].

Exclusion criteria

Individuals who had received drugs that antagonize vitamin D. For example, antiepileptics during the previous 6 months, those who had obstructive jaundice of any etiology, liver cell failure (detected clinically, in the laboratory, or by ultra-sound), chronic diarrhea, nephrotic syndrome, and individuals in a coma on either tube feeding or TPN were excluded from the study.

Data management and statistical analysis

The data were collected, revised, verified, and analyzed statistically using the SPSS statistical package. Statistical analysis was carried out using SPSS software package, version 12 (SPSS Inc., Chicago, Illinois, USA). Data were expressed as mean±SD. Student's *t*-test was used for independent samples. Comparison of quantitative variables between groups was performed using analysis of variance, post-hoc tests were used to determine least significant difference, and Spearman's correlation coefficient was used to study the correlation between the different variables studied.

Results

The descriptive data of all the groups studied with a comparison between them of the clinical and laboratory parameters (Table 1) showed no significant differences among the studied groups, except a significantly high waist circumference in group II. In terms of vitamin D, we found a highly statistically significant difference between group I and group II (Table 2). Also, a highly statistically significant difference was found between group I and group III, being the highest in group III and the lowest in group II (Table 3). Further, we compared vitamin D levels between the studied groups and their relation to vitamin D intake as well as to sun exposure, and it was found that there was a highly significant difference between all groups in relation to vitamin D intake in the diet, being the highest in group III and the lowest in group II (Table 4). There was also a statistically significant difference between all groups in relation to sun exposure, being the highest in group III and the lowest in group II (Table 5). In terms of the correlation of vitamin D and other measured parameters, we found no significant correlation among the individuals in group I, a significant correlation with calcium in group II, and a significant positive correlation with AST in group III (Table 6).

Discussion

In the present study, on comparing vitamin D levels between geriatric homebound, nursing home residents and ambulatory individuals, we found the highest vitamin D level in group III of community-dwelling ambulatory elderly individuals, with *P* less than 0.001; this may be because of good intake of vitamin D in the

Table 1 Descriptive data of all the groups studied and comparison between them of all clinical and laboratory parameters (*N*=30)

	Group 1	Group 2	Group 3	*P* value
Age (years) (mean±SD)	68.21±5.32	65.89±5.07	68.32±5.33	0.154
Sex [*n* (%)]				
Male	12 (40)	17 (56.67)	14 (46.67)	0.404
Female	18 (60)	13 (43.33)	16 (53.33)	
Veiled	10 (55.5)	9 (69.23)	7 (43.75)	0.68
Weight (kg/m^2) (mean±SD)	83.41±15.35	88.46±16.87	81.07±15.49	0.213
BMI (mean±SD)	30.66±4.77	31.76±5.70	29.33±5.20	0.25
Waist circumference (cm) (mean±SD)	89.14±11.49	98.68±20.73	88.96±12.85	0.033
SBP (mean±SD)	122.6±22.9	129.6±21.8	127.5±18.8	0.46
DBP (mean±SD)	76.1±9.2	78.4±10.9	77.3±10.5	0.7
Pulse (mean±SD)	85.6±11.31	85±7.48	86.43±8.07	0.841
RR (mean±SD)	17.29±1.65	17.29±1.56	17.64±1.73	0.646
Temperature (mean±SD)	37.32±0.38	37.15±0.35	37.19±0.35	0.215
Vitamin D (nmol/l)	70 (14–194)	16 (4–194)	158 (18–240)	
Serum calcium (mg%) (minimum–maximum)	8.821 (7.4–10)	7.985 (7.5–8.5)	8.925 (7.5–10.6)	0.198
Serum phosphorus (mg%)	3.904 (2.1–5.2)	4.039 (2.9–5.3)	4.379 (2.3–6.6)	0.058
TLC	9.29 (3–22)	7.55 (3–14)	7.55 (4–16)	0.063
Serum creatinine (mg/dl)	1.44 (1.20–3)	1.81 (1.45–4)	1.96 (1.2–6)	0.215
AST (IU/l)	30.75 (21.0–56)	39.5 (35.5–187)	38.14 (29.50–85)	0.406
ALT (IU/l)	27.32 (21.0–55)	39.61 (39.0–167)	36.07 (26.5–92)	0.2

ALT, alanine transaminase; AST, aspartate transaminase; DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure; TLC; total lung capacity.

diet (64.30%), with good and sufficient sun exposure (60%), compared with group II of care unit elderly individuals, who showed the lowest level of vitamin D. This could be because group II had little intake of vitamin D in the diet (50.00%) and 36.67% of the participants received no exposure to sunlight. This finding is in agreement with other studies [19] that clarified that vitamin D deficiency is common in older residents of nursing homes and in patients with hip fracture, and this is because of the fact that older individuals do not often go outside in the sunshine and dietary vitamin D intake is low. Other studies have also shown that failure to provide vitamin D supplements in the diet can lead to rickets in infants and osteomalacia in older individuals[20]. Others [21] have also reported that individuals with limited intake of foods rich in vitamin D are at a higher risk of developing vitamin D deficiency.

However, others clarified that the skin's manufacture of vitamin D is extraordinarily rapid and remarkably robust; production after only a few minutes of sunlight easily exceeds dietary sources by an order of magnitude. Incidental sun exposure, not dietary intake, is the principal source of vitamin D stores and is a function of the skin surface area exposed [22].

In terms of sun exposure, we found that group III had the highest level of sun exposure compared with

Table 2 Comparison between group I and group II of serum level of 25(HO) cholicalciferol

	Group I	Group II
Vitamin D [median (range)] (minimum–maximum)	70 (14–194)	16 (4–194)

Group I versus group II *P*<0.001 (highly significant).

Table 3 Comparison between group I and group III of serum level of 25(HO) cholicalciferol

	Group I	Group III
Vitamin D [median (range)] (minimum–maximum)	70 (14–194)	158 (18–240)

Group I versus group III *P*<0.001 (highly significant).

Table 4 Comparison between the three groups studied of vitamin D intake

	Group			Total	*P* value
	I	II	III	1	
Nutrition					
Good intake of vitamin D					
Count	15	6	19	40	
Within group (%)	50.00	17.90	64.30	44.00	
Average intake of vitamin D					
Count	9	10	7	26	
Within group (%)	28.60	32.10	21.40	27.40	
Little intake of vitamin D					
Count	6	14	4	24	0.005
Within group (%)	21.40	50.00	14.30	28.60	
Total					
Count	30	30	30	90	
Within group (%)	100.00	100.00	100.00	100.00	

Table 5 Comparison between the three groups in sun exposure

	Group			Total	*P* value
	I	II	III	1	
Sun exposure					
No sun exposure					
Count	2	11	0	13	
Within group (%)	6.60	36.67	0	14.44	
Little sun exposure<10 min/day					
Count	14	10	12	36	
Within group (%)	46.46	33.33	40	40	
Good sun exposure 10–15 min/day					
Count	14	9	18	41	0.013 (s)
Within group (%)	46.46	30	60	45.56	
Total					
Count	30	30	30	90	
Within group (%)	100.00	100.00	100.00	100.00	

s, significant.

Table 6 Correlation coefficient between vitamin D, age, and laboratory finding in the groups studied

	Group I		Group II		Group III	
	ρ	*P* value	ρ	*P* value	ρ	*P* value
Age (years)	–0.151	0.442	0.077	0.696	–0.017	0.932
Calcium level	288	0.137	0.199	0.031	0.131	0.506
Phosphorous level	–0.082	0.678	0.139	0.480	–0.018	0.927
Alkaline phosphatase	0.323	0.094	0.181	0.357	212	0.278
Serum creatinine	–0.058	0.769	–0.036	0.856	0.001	0.995
ALT	–264	0.175	–0.111	0.573	266	0.172
AST	–0.016	0.937	–0.128	0.515	0.418*	0.027
Hemoglobin	257	0.186	0.024	0.904	–0.134	0.497

ALT, alanine transaminase; AST, aspartate transaminase. *Significant.

group I and group II, and hence a higher level of vitamin D; this is in agreement with the Armas study [23], which showed that an exposure of 10–15 min of full-body summer noon-day sun or artificial ultraviolet B radiation (such as tanning beds) will result in input of more than 10 000 IU of vitamin D into the systemic circulation of most light-skinned adults. One or two such exposures per week should maintain 25(OH)D levels within an ideal range. This is also in agreement with others who found that as long as sunlight exposure is adequate, 1,25(OH)2D can be produced by the body without the requirement for ingestion in the diet [24]. However, our results are not in agreement with those of Hochwald *et al.* [25], who reported that even in a sunny country, more than 25% of patients had vitamin D deficiency.

Independent predictors of vitamin D deficiency were examined with logistic regression models that including age, race, BMI, season, and vitamin D intake [26]. In our study, we found that there was no significant difference between all groups in relation to age, sex, and wearing of a veil and this is in contrast with research that showed that covering of the skin for various religious or cultural reasons is considered a risk factor for vitamin D deficiency [27] and others who reported that the skin in old individuals can synthesize only 25% as much VTD as young individuals and the conversion of 7-dehydrocholesterol in aging skin is considerably decreased [28]. And also inconsistent with those who stated that age related lactose intolerance leads to reduced intake of fortified milk and aging kidneys may lead to decreased renal conversion of vitamin D [29].

In the present study, there was no statistically significance difference between any of the groups in relation to weight (kg) and BMI. However, there was a significant difference in waist circumference, being the highest in group II (98.68±20.73), which included individuals with little exercise or reduced mobility, and thus in whom central adiposity was diagnosed. This indicates high body fat and leads to health risks [30]; waist circumference is more sensitive in detecting central adiposity, even in the normal BMI categories [31,32]. The current results support previous findings that indicate an inverse relationship between vitamin D status and waist circumference rather than fat mass. This relationship is particularly important as abdominal fat has been implicated as an important factor in the development of type 2 diabetes; moreover, they clarified that as waist circumference is an independent risk factor for cardiovascular disease, the greater decrease in waist circumference associated with higher vitamin D intake represents a potential reduction in cardiovascular risk for metabolic disease [33,34]. Thus, they suggested that vitamin D and strength training can be considered as a potent combo to reduce dangerous visceral fat. In terms of BMI, our results are contradictory to studies that reported irreversible sequestration of vitamin D in the fat pool, especially if the BMI is above 30 and the individual participates in little outdoor activity [35].

In the present study, there was no significant difference between any of the groups in relation to clinical parameters of pulse, respiratory rate, temperature, systolic and diastolic blood pressure, as well as in relation to the measured laboratory investigations of phosphorous, total leukocytic count, serum creatinine, AST, ALT, and serum alkaline phosphatase, except calcium, which was the lowest in group II, which included elderly individuals living in nursing homes, with a significant positive correlation to vitamin D; this may be because of decreased nutrition and was in agreement with the study that found that a low calcium intake worsens vitamin D deficiency by increasing the turnover of vitamin metabolites by secondary hyperparathyroidism [36]. However, others have reported that a high calcium intake does not completely protect against secondary hyperparathyroidism, and thus cannot compensate for vitamin D insufficiency [37].

In the current study, we found no significant correlation between vitamin D and any of the measured parameters (age, laboratory tests) in group I, but a significant positive correlation with calcium in group II and a significant positive correlation with serum glutamic oxaloacetic transaminase in group III; this is not in agreement with researches that have reported that the risk of a high level of ALT, AST, or γ-glutamyl transpeptidase tended to be higher for individuals with lower vitamin D levels [38].

Conclusion

Elderly Egyptian individuals in nursing houses have a major health problem in the form of vitamin D deficiency and this must be addressed with long-term strategies with public education, national health policies for screening and prevention through good intake of vitamin D and calcium in the diet, good sun exposure for 10–15 min/day, and suitable strength training programs.

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Conflicts of interest

There are no conflicts of interest.

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