Relationship of serum vitamin D level on the possibility of geriatric syndrome in elderly persons

Eman Z. Azzam[a], Noha M. Elsabagh[a], Nany H. Elgiar[a], Doreen N. Younan[b], Mervat A. Badreldeen[a]

Departments of [a]Internal Medicine, [b]Clinical Pathology, Alexandria Main University Hospital, Alexandria, Egypt

Correspondence to Mervat A. Badreldeen, MSc, Alexandria Main University Hospital, Alexandria, 21521, Egypt.
Tel: +20 106 353 8480;
e-mail: mervat.badreldeen@yahoo.com

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Background
This study aimed at evaluating serum level of vitamin D in normal elderly persons above or equal to 65 years of age and its relation to geriatric syndrome.
Patients and methods
A prospective study was done on 50 normal elderly persons above 65 years (23 persons from nursery home and 27 persons from geriatric outpatient clinic in Alexandria Main University Hospital). All the participants were subjecting to full history taking, complete physical examination, laboratory assessment including serum 25-hydroxyvitamin D (OH)D by enzyme-linked immunosorbent assay, and geriatric syndrome assessment using five methods, namely, fall risk assessment using timed up and go test, mini-mental state examination, geriatric depressive scale, mini-nutritional assessment, and Tinetti performance-oriented mobility assessment.
Results
According to vitamin D level (ng/ml), the number of patients who were deficient (<12), insufficient (12–20), and sufficient (>20) was 11, 24, and 15, respectively. The mean±SD vitamin D level was 18.44±10.71 for all patients. According to the relation between vitamin D level and demographic data for the studied group, there were significant positive associations between low vitamin D level on one side and female sex (P=0.024), advanced age (P=0.026), no sun-exposure jobs (P=0.001), and nursing home residency on the other side.
Mini-mental state examination (P=0.006) and geriatric depressive scale (P=0.002) had a significant positive correlation with low vitamin D level, whereas mini-nutritional assessment (P=1.000), timed up and go test (P=0.225), and performance-oriented mobility assessment score (P=0.133) had no significant correlation with low vitamin D level.
Conclusion
There is a correlation between vitamin D deficiency and advanced age, cognitive dysfunction, and depression, whereas no correlation was found between vitamin D deficiency and nutritional state and risk of falling.

Keywords:
elderly, geriatric syndrome, vitamin D

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Introduction

Aging is a physiological process. Most people in their 60s and early 70s are still fit, active, and able to care for themselves. However, some elderly people have geriatric syndrome such as delirium, falls, incontinence, and frailty. Geriatric syndrome is highly prevalent, multifactorial, and associated with substantial morbidity and poor outcomes [1].

Geriatric syndrome and physical performance impairment are commonly considered as multidimensional clinical conditions in older persons. It is characterized by decline of functional, cognitive status, and capacities of an elderly person having exogenous and endogenous stressors [2].

Physical performance impairment is an important contributor to increase risk of geriatric syndrome that results in frailty, loss of independence, and mortality [3].

Vitamin D is known to be important for mineral bone metabolism and muscle tissue [4]. Two forms are important in humans: vitamin D2, which is made by plants, and vitamin D3, which is made by human skin when exposed to sunlight. Foods may be fortified with vitamin D2 or D3 such as oily fish, vitamin D-fortified dairy products, and egg yolk.

The major role of vitamin D is to maintain normal serum levels of calcium and phosphorus. It helps the body to absorb calcium. It is used alone or together with calcium to improve bone health and decrease fractures and fracture risks, and it may also protect against osteoporosis, hypertension, cancer, obesity, and other diseases [5].

As recently reported low serum vitamin D level is a common health problem for elderly persons, and it is associated with a decrease in physical performance and increase in fall incidence as well as risk of fractures [6].

Furthermore, it has been demonstrated that those with low serum vitamin D level has more risk of cognitive impairment, depression, and anxiety [7].

The definition of vitamin D deficiency in elderly was changed over the past few years from less than 20 ng/ml to less than 32 ng/ml [8].

Vitamin D deficiency is a prevalent and often undertreated condition in the elderly [9]. Most deficiencies result from reduced sunlight exposure (one main source of vitamin D) and limited dietary intake of vitamin D [10]. Therefore, supplementation for long-term care residents is advised to prevent deficiency and maintain adequate serum 25-hydroxyvitamin D level [11]. For community-dwelling elderly, the Institute of Medicine recommends a daily intake of 800 IU vitamin D and a 25(OH) D level of at least 20 ng/ml, whereas the Endocrine Society and the American Geriatrics Society suggest a higher level of 30 ng/ml of vitamin D [12]. Although numerous studies have demonstrated a strong association between low 25(OH) D levels and poor outcome, there is no consensus as to what supplemental dose and/or serum level may be adequate for optimal function in frail elderly [11].

Vitamin D deficiency induces defects of bone mineralization leading to clinical manifestations such as osteomalacia in adults. Vitamin D deficiency and insufficiency coincide with osteoporosis, a disorder characterized by low bone mineral density and increased risk of fracture, resulting in the majority of cases affected by impaired muscular function, leading to falls [13].

Patients and methods

During a 12-month period from May 2017 to April 2018, a prospective study of 50 normal elderly persons equal or above 65 years (23 persons from nursery home and 27 persons from geriatric outpatient clinic) was conducted. The protocol of the study was approved by Alexandria faculty of medicine ethical committee.

Inclusion criteria

Normal elderly persons equal or above 65 years, with or without geriatric syndrome, male or female, were included.

Exclusion criteria

Any chronic illnesses that potentially alter vitamin D metabolism, liver or renal diseases, receiving vitamin D treatment, and the use of medications that affect bone metabolism such as bisphosphonates were the exclusion criteria.

After giving their signed informed consent, all the participants were subjected to the following:

(1) Full history taking, laying stress on the age, type of work, exposure to sun, history of previous falls or fractures, presence of chronic illness, and detailed drug history, including drugs affecting bone metabolism, as well as vitamin D supplements.
(2) Complete physical examination including the following:
    (a) Fall risk assessment using 'timed up and go test' [14].
    (b) BMI [13].
(3) Laboratory assessment including the following:
    (a) Measurement of serum 25-hydroxyvitamin D by enzyme-linked immunosorbent assay [15].
    (b) Measurement of serum calcium [16] and serum phosphorus [17].
    (c) Estimation of serum level of thyroid-stimulating hormone (TSH) [18].
    (d) Estimation of serum level of parathyroid hormone (PTH) [19].
    (e) Estimation of serum level of C-reactive protein (CRP) [20].
(4) Mini-mental state examination [21].
(5) Geriatric depressive scale [22].
(6) Mini-Nutritional State [23].
(7) Tinetti performance-oriented mobility assessment (POMA) [24].

Results

Regarding sex distribution, the studied group consisted of 30 (60%) males and 20 (40%) females. There were 18 patients aged 65 years old and 32 patients aged above 65 years, representing 36 and 64% of the studied group, respectively. The mean±SD age was 67.24±3.07 years. According to BMI, there were no patients with BMI less than 18 kg/m^2 or more than 40 kg/m^2. The number of patients with normal healthy weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), grade I obesity (30–34.9 kg/m^2), and grade II obesity (35–39.9 kg/m^2) was 20, 17, 9, and 4, respectively. The mean ±SD BMI was 26.60±5.25 kg/m^2. Although 38 (76%) patients had non-sun-exposure jobs, only 12 (24%) patients had sun-exposure jobs. Twenty-three (46%) patients lived in nursing residency and 27 (54%) patients lived at home.

According to vitamin D level (ng/ml), the number of patients who were deficient (<12 ng/ml), insufficient (12–20 ng/ml), and sufficient (>20 ng/ml) was 11 (22%), 24 (48%), and 15 (30%), respectively. The mean±SD vitamin D level was 18.44±10.71 ng/ml for all patients. The mean±SD TSH level was 3.13 ±2.33 mIU/l, whereas the mean±SD PTH level was 40.64±16.35 pg/ml. The mean±SD calcium level was 8.50±0.78 mg/dl and the mean±SD phosphorus level was 3.43±0.91 mg/dl. There were 21 patients with negative CRP result (42%), whereas patients with positive CRP result was 29 (58%). The mean±SD CRP level for all patients was 10.65±13.21 mg/l.

According to mini-mental state examination, there were patients who were neither diagnosed as have severe (≤17) nor marked cognitive dysfunction (18–25). However, 9/50 (18%) patients had borderline cognitive score (26–28), and 41/50 (82%) patients had normal score (29–30). According to mini-nutritional assessment, no patients scored as malnourished (0–7), whereas the number of patients who scored as being at risk of malnutrition (8–11) and normal (12–14) was 6/50 (12%) and 44/50 (88%), respectively. According to timed up and go test, only 5/50 (10%) patients had a high risk of falls and the rest of the studied group (45/50) (90%) had no risk of falls. Regarding geriatric depression scale, no patients scored as very depressed, whereas normal and mildly depressed patients were 46/50 (92%) and 4/50 (8%), respectively. According to POMA score, no patients had a high fall risk, whereas the number of patients scored as moderate fall risk (19–24) and low fall risk (25–28) was 26 (52%) and 24 (48%), respectively, and the mean ±SD score for all patients was 23.64±2.59. According to routine investigations of CBC, mean hemoglobin, white blood cells, and platelets were 12.67±1.14 g/dl, 6.57±1.38×10^3, and 240.7±53.89×10^3, respectively. However, the mean±SD urea and creatinine levels were 20.78±6.99 and 1.05/±0.82 mg/dl, respectively. The mean±SD fasting blood sugar was 97.38±7.91 mg/dl, whereas the mean±SD SGOT and SGPT levels were 20.52±7.57 and 20.66±6.65 U/l, respectively. According to relation between low vitamin D level and demographic data for the studied group, there were significant associations between low vitamin D level on one side and female sex (*P*=0.024), advanced age (*P*=0.026), no sun-exposure jobs (*P*=0.001), and nursing home residency on the other side (*P*=0.008) (Table 1). Mini-mental state examination (*P*=0.006) and geriatric depression scale (*P*=0.002) had a positive significant correlation with low vitamin D level, whereas CRP (*P*=0.627), mini-nutritional assessment (*P*=1.000), timed up and go test (*P*=0.225), and

Table 1 Relation between vitamin D and demographic data (*N*=50)

	Vitamin D (ng/ml) [*n* (%)]				
	Deficient (*N*=11)	Insufficient (*N*=24)	Sufficient (*N*=15)	χ^2	*P*
Sex					
Male	3 (27.3)	15 (62.5)	12 (80.0)	7.472*	0.024*
Female	8 (72.7)	9 (37.5)	3 (20.0)		
Age (years)					
65	1 (9.1)	8 (33.3)	9 (60.0)	7.281*	0.026*
>65	10 (90.9)	16 (66.7)	6 (40.0)		
BMI (kg/m^2)					
Normal healthy weight (18.5–24.9)	2 (18.2)	11 (45.8)	7 (46.7)		
Over weight (25–29.9)	4 (36.4)	8 (33.3)	5 (33.3)	6.761	^{MC}P=0.319
Grade I obesity (30–39.9)	2 (18.2)	4 (16.7)	3 (20.0)		
Grade II obesity (35–39.9)	3 (27.3)	1 (4.2)	0 (0.0)		
Type of work					
No (no sun-exposure)	10 (90.9)	22 (91.7)	6 (40.0)	13.327*	^{MC}P=0.001*
Yes (sun-exposure)	1 (9.1)	2 (8.3)	9 (60.0)		
Residency					
Nursing home	9 (81.8)	11 (45.8)	3 (20.0)	9.764*	0.008*
Home	2 (18.2)	13 (54.2)	12 (80.0)		

χ^2, χ^2 test; MC, value for Monte Carlo. Deficient, less than 12. Insufficient, 12–20. Sufficient, more than 20. *P*, *P* value for comparing between three categories. *Statistically significant at *P* value less than or equal to 0.05.

POMA score (P=0.133) had no significant correlation with low vitamin D level (Table 2).

Table 3 shows that advancing age (P=0.012), high BMI (P=0.030), high PTH (P=0.23), low calcium level (P=0.001), and low phosphorus level (P=0.014) had a significant correlation with low vitamin D level, whereas TSH, CRP, and POMA test had no significant correlation.

Discussion

In this study, we aimed at evaluating the prevalence of vitamin D deficiency among elderly persons and its relation to geriatric syndrome. Results of this work showed that the prevalence of hypovitaminosis D was 70% (35/50 patients) in normal elderly persons. This result is in agreement with Shinchuk *et al.* [25] who found prevalence among elderly patients ranged from 68.4 to 94%. On the contrary, this result disagrees with Kiebzak and colleagues who reported a prevalence of 11.0 and 8.1%, respectively. This contradiction may be owing to the definition of vitamin D deficiency used by Kiebzak *et al.* [26] who defined vitamin D deficiency and insufficiency as 25(OH) D level less than 8 and 10 ng/ml, respectively.

Vitamin D deficiency in the present study was more prevalent with advancing age, female sex, type of work (with sun-exposure or not), and residency (home or nursing residency). Regarding significant relation between advancing age and vitamin D deficiency, this result matched with Oren *et al.* [27] but did not match with Hovsepian *et al.* [28], who found that vitamin D deficiency is associated with younger age. The reason why many studies found that there was a relation between vitamin D deficiency and older age is that older people are prone to many risk factors such as decreased dietary intake, diminished sunlight exposure, increased skin thickness, impaired intestinal absorption, and impaired hydroxylation in the liver and kidney.

This study concluded that there is a significant relation between vitamin D deficiency and low sun-exposure,

Table 3 Correlation between vitamin D and different parameters (*N*=50)

	Vitamin D (ng/ml)	
	r_s	P
Age (years)	–0.354*	0.012
BMI (kg/m^2)	–0.306*	0.030
TSH (mIU/l)	0.033	0.821
PTH (pg/ml)	–0.320*	0.023
Calcium (mg/dl)	0.461*	0.001
Phosphorus (mg/dl)	0.345*	0.014
CRP (mg/l)	0.000	1.000
POMA	–0.122	0.399

CRP, C-reactive protein; POMA, performance-oriented mobility assessment; PTH, parathyroid hormone; r_s, Spearman's coefficient; TSH, thyroid-stimulating hormone. *Statistically significant at P value less than or equal to 0.05.

Table 2 Relation between vitamin D and different parameters (*N*=50)

	Vitamin D (ng/ml) [n (%)]				
	Deficient (*N*=11)	Insufficient (*N*=24)	Sufficient (*N*=15)	χ^2	P
CRP (mg/l)					
Negative (<3)	6 (54.5)	9 (37.5)	6 (40.0)	0.935	0.627
Positive (>3)	5 (45.5)	15 (62.5)	9 (60.0)		
Mini-mental state examination					
Border line cognitive (26–28)	5 (45.5)	4 (16.7)	0 (0.0)	8.249*	^{MC}P=0.006*
Normal (29–30)	6 (54.5)	20 (83.3)	15 (100.0)		
Mini-nutritional assessment					
At risk of malnutrition (17–23.5)	1 (9.1)	3 (12.5)	2 (13.3)	0.282	^{MC}P=1.000
Normal (24–30)	10 (90.9)	21 (87.5)	13 (86.7)		
Timed up and go test					
Normal (<16)	10 (90.9)	20 (83.3)	15 (100.0)	2.563	^{MC}P=0.225
Indicate high risk of falls (≥16)	1 (9.1)	4 (16.7)	0 (0.0)		
Geriatric depression scale					
Normal (1–4)	7 (63.6)	24 (100.0)	15 (100.0)	10.267*	^{MC}P=0.002*
Mild depressed (5–9)	4 (36.4)	0 (0.0)	0 (0.0)		
POMA					
Moderate fall risk (19–24)	3 (27.3)	13 (54.2)	10 (66.7)	4.033	0.133
Low fall risk (25–28)	8 (72.7)	11 (45.8)	5 (33.3)		

χ^2, χ^2 test; CRP, C-reactive protein; POMA, performance-oriented mobility assessment. Deficient, less than 12. Insufficient, 12–20. Sufficient, more than 20. MC, Monte Carlo. P, P value for comparing between three categories. *Statistically significant at P value less than or equal to 0.05.

and this matches with Tsur *et al.* [29]. However, it did not match with Rajah *et al.* [30], who reported no significant relation.

In the present work, vitamin D deficiency had a significant correlation with cognitive function as recorded using mini-mental state examination. This finding is in agreement with Annweiler *et al.* [31], but their population consisted of women only.

However, this study disagrees with Soul *et al.* [32] who reported no relation between vitamin D deficiency and cognitive function. This is owing to the fact that vitamin D is able to enter the cerebrospinal fluid and the brain by crossing the blood–brain barrier via passive diffusion and additional specific carriers in the cerebral capillaries or the blood–cerebrospinal fluid barrier in the plexus choroids.

This study showed significant correlation between vitamin D deficiency and depression in elderly people measured by geriatric depression scale. This matched with Lapid *et al.* [33], but their studied groups were different regarding age, sex, and place of living.

Regarding effect of vitamin D deficiency on physical activity, this study found that low vitamin D had no significant correlation with POMA score and timed up and go test. There was no strong evidence that linked vitamin D deficiency to physical activity in elderly patients. This is in agreement with some studies [34] and in disagreement with others [35]. Although vitamin D deficiency is common among elderly patients, other factors, including age-related muscular changes, malnutrition, lacking of physical activity, comorbidity, or inflammation might have had a greater effect on muscle strength and gait speed than vitamin D levels [36].

This result suggests that low vitamin D has a significant correlation with PTH, calcium, and phosphorus. The association between PTH and low vitamin D level may be an important determinant of bone remodeling, mainly in the elderly. This work has found a significant negative correlation between PTH and low vitamin D levels. This result agrees with many studies [37]. This result matches with Sahota *et al.* [38], who found that as vitamin D levels decrease, calcium absorption is suboptimal and PTH levels rise. However, Harburger *et al.* [39] found that a subnormal vitamin D level did not always relate to hypocalcemia, as more than half of their patients with their vitamin D level below 25 nmol/l had calcium level in the normal range. The explanation to their results may be owing to not exclude patients on calcium supplements.

Conclusion

There is a relation between vitamin D deficiency and advancing age, female sex, non-sun-exposure type of work, nursing home residency, cognitive dysfunction, and depression.

There is no association found between vitamin D deficiency and nutritional state and risk of falling.

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Conflicts of interest

There are no conflicts of interest.

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