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Hypovitaminosis D Among Patients Admitted With Hip Fracture to a Level-1 Trauma Center in the Sunny Upper Egypt: Prevalence and Associated Correlates

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Abstract

Introduction: Despite abundant sunshine, hypovitaminosis D is common in the Middle East. The aim of this study was to determine the prevalence of hypovitaminosis D and related correlates among patients with hip fracture in Assiut University Hospitals in Upper Egypt. **Materials and Methods:** A cross-sectional study was carried out in 133 patients with hip fracture, aged 50 years and older, admitted to Trauma Unit of Assiut University Hospitals, from January through December 2014. Patients were selected by systematic random sampling. Serum 25-hydroxy vitamin D level was measured by enzyme-linked immunosorbent assay; bone mineral density (BMD) by dual-energy X-ray absorptiometry. Weight and height measurements were used for body mass index (BMI) calculation. **Results:** Patients' median age was 70 years (range: 50-99); 51.9% were females. Osteoporosis (femoral neck T score: <-2.5 standard deviation) prevalence was 72.2%. Of all patients, 60.9% had vitamin D deficiency (<20 ng/mL); 15.8% reported vitamin D inadequacy (from 20 to 29 ng/mL) and vitamin D levels were normal in 23.3% (>30 ng/mL). According to univariate analysis, vitamin D deficiency was significantly associated with obesity ($P = .012$) and low T scores of the femoral neck ($P = .001$), L2 ($P = .021$), L3 ($P = .031$), L4 ($P = .012$), and the greater trochanter ($P < .001$). In a multivariable logistic regression model, high BMI and low BMD of the femoral neck and greater trochanter were associated with hypovitaminosis D. **Conclusion:** Prevalence of hypovitaminosis D is high among patients with hip fracture and associated with low BMD and high BMI. Increasing awareness about prevention as well as detection and treatment of vitamin D deficiency is recommended.

Keywords
hypovitaminosis D, prevalence, hip fractures, Egypt

Introduction

Hip fractures have become a major health problem in many developed countries. They contribute to both morbidity and mortality in the elderly individuals. The incidence of hip fractures varies among different countries and populations and seems associated with race and geography. Hip fractures seem to increase with poor economic status, reduced winter sunlight, and water fluoridation. Altered neuromuscular coordination and vitamin D deficiency were given as reasons for a higher incidence of hip fractures during the winter season.[1] Low levels of 25-hydroxyvitamin D are reported to be associated with compromised skeletal health and poor muscular function, increasing the risk for falls and osteoporotic hip fractures, especially in older people.[2,3] Bolland and Grey analyzed 7 overlapping meta-analyses on this topic, with discordant results ranging from strong statements that vitamin D prevents fractures to equally strong statements that vitamin D without calcium does not prevent fractures. However, they showed substantial differences in trial selection, outcome definition, and analytic methods between overlapping meta-analyses.[4]

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The prevalence of 25-hydroxy vitamin D inadequacy appears to be higher in patients with hip fractures.[5] More severe vitamin D deficiency seems to be associated with more severe osteoporotic hip fractures.[6]

There is controversy in defining normal levels of vitamin D according to its role in optimum health versus lack of disease among ethnic groups. The normal value for 25-hydroxyvitamin D, stated by different organizations, ranges from 10 to 60 ng/mL. Most studies recommend 30 ng/mL as the lower limit of normal and desirable levels of 25-hydroxyvitamin D, and the approach for establishing normal levels should focus more on optimal health rather than lack of disease.[7]

Most studies defined 25-hydroxy vitamin D (25OH-D) levels of less than 20 ng/mL (50 nmol/L) as vitamin D deficiency. With this cutoff level, the prevalence of vitamin D deficiency was reported as 70% or higher in South Asia and varied from 6% to 70% in Southeast Asia.[8]

In a review conducted by the nutrition-working group of the International Osteoporosis Foundation, hypovitaminosis was defined as 25OH-D level of less than 30 ng/mL (75 nmol/L) and was prevalent in all regions of the world. Levels below 10 ng/mL (25 nmol/L) were most common in South Asia and the Middle East.[9] Predictors of low 25OH-D levels include older age, female sex, higher latitude, winter season, darker skin pigmentation, less sun exposure, dietary habits, and absence of vitamin D fortification.[10]

Although the Middle East region registers high rates of hypovitaminosis D in some published data,[11] few reports have studied the prevalence of vitamin D deficiency in the Middle East and Mediterranean regions, and there is a need to run such studies in different Middle East countries with variations in culture and climate. Egypt is the country with the largest population in the Middle East. Upper Egypt is the sunny area south of Cairo. The aim of this study was to determine the prevalence of hypovitaminosis D in patients admitted with hip fracture to the Trauma Unit in Assiut University Hospitals in Upper Egypt. In addition, the potential risk factors that may be associated with the occurrence of hypovitaminosis D were explored.

Patients and Methods

Patients 50 years or older with hip fractures who were admitted to the Trauma Unit of Assiut University Hospitals from January through December 2014 were included. Patients with bilateral hip fractures, patients with history of chronic conditions known to affect bone density, patients with polytrauma, and those who had experienced major accidents were excluded.

The study composed of 275 admitted cases with participation eligibility criteria. We used systematic random sampling as a random selection method in our study. During the study 4 cases were not included due to some technical problems in assessing the vitamin D level. The final sample included 133 patients.

Ethical approval was obtained from the local authority. Informed written consent was obtained from all the participants prior to the study.

Study Design and Assessments

This was a prospective, cross-sectional study. Patients were selected by systematic random sampling. Data collection was performed in the trauma inpatient department.

Using a structured questionnaire, personal interviews were conducted with each patient and/or patients' relatives by 2 well-trained nurses. The questionnaire contained items about sociodemographic characteristics like name, sex, age, and residence (rural or urban).

All tests were conducted after admission, including bone mineral density (BMD) measurements, serum concentration of 25OH-D level, and anthropometric measurements.

Dual-energy X-ray absorptiometry measurements of the femoral neck, greater trochanter, and L2 to L4 were made to determine the local BMD on the unaffected side. Osteoporosis was diagnosed according to the criteria of World Health Organization, that is, when the T score was −2.5 standard deviation (SD) or below for the femoral neck.

Weight and height were measured and the body mass index (BMI) was calculated. The total serum concentration of 25-hydroxy vitamin D was measured by enzyme-linked immunosorbent assay. Vitamin D serum levels were classified as vitamin D deficiency (<20 ng/mL), vitamin D inadequacy (from 20 to 29 ng/mL), normal vitamin D levels (≥30 ng/mL), and severe deficiency (<10 ng/mL).

Statistical Analysis

Data were recoded and descriptive statistics were used. χ^2 square tests were used to compare study variables according to hypovitaminosis D. Patients were identified in 2 groups as 25-hydroxy vitamin D deficient (<20 ng/mL) or not deficient (≤20 ng/mL).

Subsequently, gender, age, BMI, the femoral neck, and the greater trochanter were explored as prognostic factors for vitamin D deficiency in a multivariable logistic regression model. T scores of L2, L3, and L4 were not included in the multivariable model due to the presence of multicollinearity. The significance level was set at $P < .05$. All analyses were performed using SPSS for Windows, Version 16.0. Chicago, SPSS Inc.

Results

Of the 275 eligible patients who were admitted to the Assiut University Hospitals in 2014, a total of 133 were included in the study. The remaining patients were either not selected by the simple random sampling method or excluded due to missing vitamin D levels (4 cases based on technical issues during vitamin D determination). The median patient age was 70 years (range 50-99 years); 48.1% were males and 51.9% were females. Of the patients, 50.4% were housewives and 22.6% were farmers. The mean BMI (± SD) was 26.6 (± 3.7). The median 25-hydroxy vitamin D serum level was 18.5 ng/mL (range: 4-203 ng/mL).

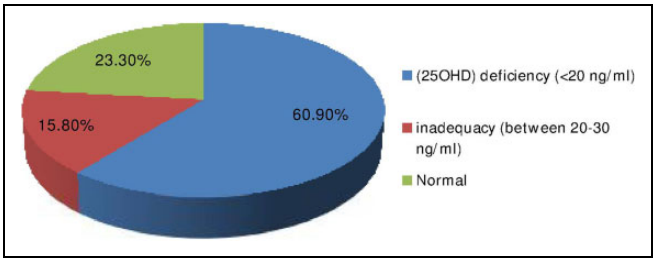

Figure 1. Prevalence of 25-hydroxy vitamin D deficiency among patients admitted with hip fracture to the trauma unit of Assiut University Hospitals.

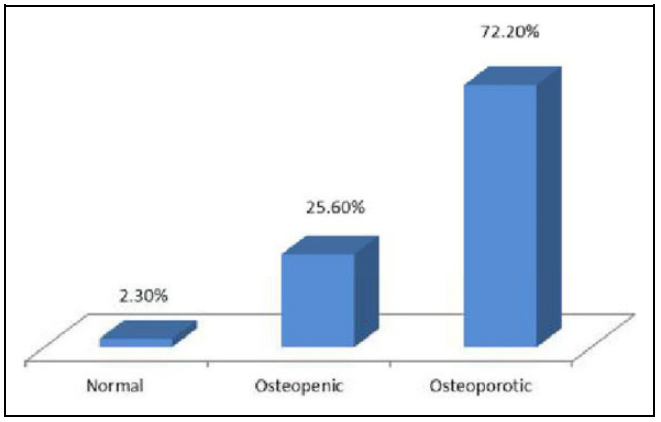

Figure 2. Prevalence of low bone mineral density among patients admitted with hip fracture to the trauma unit of Assiut University Hospitals.

Of all patients, 60.9% had vitamin D deficiency (<20 ng/mL), 15.8% reported vitamin D inadequacy (from 20 to 29 ng/mL), and 23.3% reported normal vitamin D levels (≥30 ng/mL; Figure 1). Patients with severe vitamin D deficiency (<10 ng/mL) represented 13.5% of the study population. The prevalence of osteoporosis (femoral neck T score: ≤−2.5 SD) was 72.2% (Figure 2).

According to the univariable analysis, vitamin D deficiency was associated with obesity ($P = .012$). Patients with T scores of −2.5 SD or lower reported a higher prevalence of vitamin D deficiency than patients with T score greater than −2.5 SD (femoral neck: 82.7%, $P = .001$; L2: 58.0%, $P = .021$; L3: 48.1%, $P = .031$; L4: 61.7%, $P = .012$; and greater trochanter: 79.0%, $P < .001$; Table 1).

No significant difference was found regarding the prevalence of hypovitaminosis D among farmers and housewives (67.2% and 53.3%; $P = .256$). In the multivariable logistic regression model, 2-fold increase in the chance to have a vitamin D deficiency if the BMI increases by 1 kg/m^2, also low BMD was the prognostic factor for vitamin D deficiency—patients with a femoral neck T score of −2.5 SD or lower were 5.1 times more likely to be diagnosed with hypovitaminosis D and patients with a greater trochanter T score of −2.5 SD or lower were 2.8 times more likely to get this diagnosis (Table 2). Gender and age were not found to be associated with vitamin D deficiency.

Table 1. Baseline Demographic and Medical Characteristics in Relation to Vitamin D Deficiency of the Patients Admitted With Proximal Femoral Fracture to Trauma Unit, Assiut University Hospitals.

	Hypovitaminosis D			
Variables	Yes (n = 81)	No (n = 52)	Total (N = 133)	*P* Value
Gender				.213[a]
Male	35 (43.2)	29 (55.8)	64 (48.1)	
Female	46 (56.8)	23 (44.2)	69 (51.9)	
Age, years				.047[b]
50-59	14 (17.3)	12 (23.1)	26 (19.5)	
60-69	20 (24.7)	18 (34.6)	38 (28.6)	
70-74	17 (21.0)	12 (23.1)	29 (21.8)	
75+	30 (37.0)	10 (19.2)	40 (30.1)	
BMI				.012[b]
Normal	28 (34.6)	26 (50.0)	54 (40.6)	
Overweight	30 (37.0)	21 (40.4)	51 (38.3)	
Obese	23 (28.4)	5 (9.6)	28 (21.1)	
Neck femur T score[c]				.001[a]
T score >−2.5 SD	14 (17.3)	23 (44.2)	37 (27.8)	
T score ≤−2.5 SD	67 (82.7)	29 (55.8)	96 (72.2)	
L2 T score				.021[a]
T score >−2.5 SD	34 (42.0)	33 (63.5)	67 (50.4)	
T score ≤−2.5 SD	47 (58.0)	19 (36.5)	66 (49.6)	
L3 T score				.031[a]
T score >−2.5 SD	42 (51.9)	37 (71.2)	79 (59.4)	
T score ≤−2.5 SD	39 (48.1)	15 (28.8)	54 (40.6)	
L4 T score				.012[a]
T score >−2.5 SD	31 (38.3)	32 (61.5)	63 (47.4)	
T score ≤−2.5 SD	50 (61.7)	20 (38.5)	70 (52.6)	
Greater trochanter T score				<.001[a]
T score >−2.5 SD	17 (21.0)	30 (57.7)	47 (35.3)	
T score ≤−2.5 SD	64 (79.0)	22 (42.3)	86 (64.7)	

Abbreviations: BMI, body mass index; SD, standard deviation.
[a]*P* values derived from χ^2 test.
[b]*P* values derived from Mantel-Haenszel χ^2 test.
[c]Neck femur T score ≤−2.5 SD is considered as osteoporosis among the study sample.

Discussion

In this study, the prevalence of hypovitaminosis D and associated predictors were evaluated among patients admitted with hip fracture to a level-1 trauma center serving the population in a wide central area of the sunny Upper Egypt. About 61% of the included patients had 25-hydroxy vitamin D deficiency (<20 ng/mL), a slightly higher proportion than reported by an outpatient rheumatology clinic in Qatar (56% of 340 healthy volunteers using the same cutoff level).[12] Of the 1210 randomly selected Iranian men and women, 8% had 25OH-D levels below 5 ng/mL and 60% had levels below 10 ng/mL.[13] In Singapore, vitamin D deficiency was reported in 57.5% of 412 patients with hip fracture and insufficiency was reported in 34.5%; only 8% of patients had normal vitamin D levels.[14] In other studies, prevalence of 25-hydroxy vitamin D deficiency was higher compared to our study: In an Italian study, vitamin

Table 2. Multivariable Logistic Regression Analysis for the Associated Predictors With Vitamin D Deficiency in the Patients Admitted With Proximal Femoral Fracture to Trauma Unit, Assiut University Hospitals.

Variables	Category/Increment	Odds Ratio	95% Confidence Interval	*P* Value
Gender	Male	Baseline	–	–
	Female	0.85	0.35-2.06	.716
Age	<75 years	Baseline	–	–
	75+ years	1.78	0.69-4.57	.229
BMI		2.24	1.09-3.40	.001
Neck femur Tscore	>−2.5 SD	Baseline	–	–
	≤−2.5 SD	5.10	1.91-13.59	.001
Greater trochanter T score	>−2.5 SD	Baseline	–	–
	≤−2.5 SD	2.76	1.07-6.89	.021

Abbreviations: BMI, body mass index; SD, standard deviation.

D deficiency (<25 ng/mL) was found in 67% of 324 patients admitted with hip fracture. In Japan, serum 25OH-D levels were lower than 20 ng/mL in 90% of patients with hip fracture.[15] In Russia, hypovitaminosis D (<25 nmol/L) was reported in 65% of patients with hip fracture.[16]

Although Upper Egypt is sunny almost throughout the year, in our study, we reported vitamin D deficiency in patients with hip fracture similar to Norway, Japan, and North America. This may be explained by the lack of community awareness about vitamin D deficiency, inadequate intake of fortified foods with vitamin D, lack of adequate exposure to sun in elderly individuals, and decrease in body surface area exposed to sun due to dress traditions. These points raise the interest of running a national survey and further population-based studies.

In a population-based study among 362 reproductive age women in rural Upper Egypt, 61% were of low socioeconomic status and 47.8% were illiterates.[17] Bone mineral density was low in 31.8% of the women. These findings may indicate worse bone density conditions and an increased hip fracture risk among older age-groups in a close-related community. The low socioeconomic status along with the low calcium intake may aggravate the consequences of 25-hydroxy vitamin D deficiency, which is reported by many studies.[4,18]

In our study, 13.5% of patients had vitamin D serum level below 10 ng/mL. In the elderly Lebanese, 37% of men and 56% of women had 25OH-D levels below 10 ng/mL.[19]

The majority (72%) of our patients were diagnosed with osteoporosis. A higher proportion (82.7%) of patients with hip fracture having osteoporosis were diagnosed with hypovitaminosis D than patients without osteoporosis. In a multivariable regression model, patients with osteoporosis were 5 times more likely to have vitamin D deficiency than patients without osteoporosis. Furthermore, a higher proportion of patients with low BMD measured at L2, L3, L4, and the greater trochanter had a vitamin D deficiency than patients with normal BMD. In a multivariable regression model, patients with a low BMD at the greater trochanter had a 3 times higher chance of having vitamin D deficiency compared to patients with normal BMD.

The significant relation of low bone density and vitamin D deficiency is consistent with that reported by Napoli et al,[20] Rossini et al,[21] and Larrosa et al.[22]

There was a significant association of higher BMI and vitamin D deficiency, a significant decrease in serum 25(OH) D3 levels with increasing BMI was reported among population of 2126 patients in Oslo, Norway,[23] and in a study done among women with osteoporosis in Lebanon.[24] This finding may be explained by the fact that the fat-soluble vitamin D is stored in the body fat, which reduces its bioavailability.[25] Also, it may be attributed to less outdoor activities and exercises of obese patients and therefore less sun exposure.

Hypovitaminosis D was not associated with gender and age. For gender, this is consistent with a report from Singapore,[14] whereas it is not consistent with other published data from Iran[13] and Lebanon.[19] For age, no significant relation was found with Ramason et al in Singapore,[14] whereas significant relation was found with Saadi et al in a total of 259 Emirati women (175 pre- and 84 postmenopausal; age range 20-85 years).[26]

The limitations of the study include the relatively small sample size and a possible selection bias, as the study included 133 patients admitted with hip fracture to a tertiary care hospital in 1 year. In this setting, patients are referred to the trauma facility from different areas of Upper Egypt for management, which is offered free of charge. This might have excluded other patients with possible higher socioeconomic status treated in other facilities and consequently would have affected the results of the study.

Conclusion

Prevalence of hypovitaminosis D is high among patients admitted with hip fracture to a level-1 trauma center serving a wide area of the central sunny Upper Egypt. Sun exposure, therefore, is not reliable to indicate a sufficient vitamin D level. Associated predictors were low BMD and high BMI. Increasing awareness about prevention and detection and treatment of vitamin D deficiency are recommended.

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Declaration of Conflicting Interests

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