ORIGINAL ARTICLE

Calciferol Deficiency among Asymptomatic Adult and Elderly Population: An Early Risk Identification of Bone Mineral Density Disorders

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Abstract

Background: Risk identification of the essential bone's vitamin among vulnerable subjects while still asymptomatic allows early intervention to prevent the development of bone illnesses and related complications. **Aim:** To evaluate Vitamin D laboratory testing during medical practice at the outpatient family medicine and internal medicine clinic of an academic hospital. **Materials and Methods:** A single-center retrospective observational study was conducted by reviewing the files of attendances at the outpatient clinic who were aged above 25 years old during the period from 2021 to 2024. Data regarding 25-hydroxyvitamin D laboratory results were collected for different age groups, including adults and the elderly, both at initial testing and follow-up. **Results:** 723 subjects were enrolled. Vitamin D deficiency was significantly higher among young adults aged 25–50 years, while excess Vitamin D was significantly higher frequency among the geriatric age group. 323 subjects (43.5%) had abnormal Vitamin D levels (304 were deficient and 19 had excess vitamin D), with a high missed follow-up rate of 76%. Geriatric age group (adjusted odds ratio [aOR] 6.742), middle-aged adults (50–64 years old) (aOR 2.868), and deficient Vitamin D level (aOR 2.732) were significant independent predictors for attendance for follow-up. **Conclusion:** Vitamin D deficiency is still high among all age groups; however, it tends to decline among those older than 50 years who attend for regular health care visits. Missing follow-up among those with abnormal Vitamin D status represents a major challenge during medical practice. Vitamin D testing is a valuable tool for risk stratification of vulnerable groups who are at high risk for Vitamin D insufficiency.

Key words: Adults, Follow-up, Geriatrics, Vitamin D

INTRODUCTION

Over the past decade, Vitamin D get an increasing interest among both physicians and the general population. In addition to its role in maintaining adequate bone mineralization, adequate Vitamin D has a protective role against inflammation, allergies, autoimmune disorders, malignancy, depression, cardiovascular events, insulin resistance, and metabolic syndrome.[1] Insufficient Vitamin D adversely worsens the severity and complications of many chronic illnesses, such as bronchial asthma, diabetes mellitus, obesity, and atherosclerosis.[2]

Vitamin D insufficiency is common in western countries due to cloudy weathers; however, even in sunny countries, Vitamin D insufficiency is highly prevalent.[3] The prevalence of Vitamin D deficiency ranged between 30% and 50% worldwide. The elderly are a vulnerable group for deficient Vitamin D. The prevalence of Vitamin D deficiency among the geriatric population ranged between 16% in studies consider deficiency at a cutoff value <30 ng/dL 59.7% in studies consider deficiency at a cutoff value <20 ng/dL.[4]

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The Endocrine Society clinical practice guidelines recommend empiric Vitamin D for vulnerable groups includes children <18 years old, the elderly aged above 75 years, pregnant females, and subjects with chronic medical illness. For adults and the elderly population aged <75 years, the recommendation is to provide adequate daily requirement but avoid empiric excessive Vitamin D supplementation or routine Vitamin D testing.[5]

Vitamin D can be obtained either from dietary intake or as pharmacological supplements. Despite of wide disseminated dietary sources but natural Vitamin D needs to be activated through the skin through sun exposure. Daily Vitamin D requirement varies with age ranged between 400 IU daily for adults aged 19–50 years old and 800 IU daily for adults aged above 50 years old.[6]

Despite of lacking evidence for testing of Vitamin D circulating level in the adult population, several researches demonstrated a high prevalence of insufficient Vitamin D among this age group. Evidences from Saudi Arabia revealed that up to 60% of the adult population aged 18–60 years have Vitamin D deficiency.[7] Improper nutritional habits, with a lack of optimal physical activity and adequate sun exposure, represent a major challenge against fulfillment of the sufficient Vitamin D dietary reference intake. Providing the daily requirement of Vitamin D as pharmacological supplements is a good alternative to ensure sufficient intake of Vitamin D for all age groups. With increased public awareness of the medical importance of maintaining a sufficient level of Vitamin D, testing for Vitamin D status is much raised in the previous few years. Furthermore, over-the-counter consumption of nutritional preparations, including Vitamin D has emerged as a risk for hypervitaminosis D.[8]

Circulating 25-hydroxyvitamin D (25(OH)D) level is the most reliable biomarker reflecting Vitamin D status. Testing is recommended for symptomatic subjects or risky populations, including vulnerable ages, chronic renal insufficiency, obesity, malabsorption, and metabolic disorders. However, the high prevalence of Vitamin D insufficiency among asymptomatic apparently healthy adult populations with emerging nutritional, lifestyle, and environmental changes that promote inadequate Vitamin D daily intake makes a great urge for the development of standardized national protocols for testing and prophylactic intervention addressing the local risk factors for Vitamin D insufficiency. In clinical practice, laboratory testing of Vitamin D levels may be over requested.[9]

The present study aims to evaluate Vitamin D laboratory testing during medical practice at an outpatient family medicine and internal medicine clinic of a university hospital.

MATERIALS AND METHODS

Study population

Data for this hospital-based retrospective observational study were obtained from reviewing files of attendances at the outpatient family medicine and internal medicine clinic at an academic medical center during the period from 2021 to 2024.

Inclusion criteria

The adult population included both males and females aged above 25 years old who had requested 25-hydroxy Vitamin D serum level at the outpatient family medicine and internal medicine clinic at the university hospital during the period from January 2021 to December 2024.

Exclusion criteria

Files with insufficient or missed data regarding 25(OH)D serum level.

Methods

All files of outpatient subjects older than 25 years were revised, and data regarding 25(OH)D laboratory investigations were extracted, including age, sex, residence, education, work, marital status, associated medical illness, indications for Vitamin D testing, and 25(OH)D Serum level.

The included subjects were classified by age into 3 groups:

- Group 1: Young adults aged 25–50 years old
- Group 2: Middle-aged adults aged more than 50 years till 64 years old
- Group 3: Elderly (geriatrics) aged 65 years old and more.

Serum level of Vitamin D (25(OH)D) was tested using Chemiluminescent Immunoassay (COBAS e411). Based on serum 25(OH)D serum level, Vitamin D status was classified as:[10]

- Deficient: Serum 25(OH)D level <20 ng/mL (<50 nmol/L)
- Sufficient: Serum 25(OH)D level 20–60 ng/mL (≥ 75 nmol/L)
- High: Serum 25(OH)D level exceeds 60 ng/mL (>150 nmol/L).

Ethical approval

This study was approved by the University Research Ethics Committee [SCBR-480/2025].

Statistical analysis

Statistical analysis of collected data was performed through the Statistical Package for the Social Sciences software program (version 26). Categorical variables were expressed as numbers and percentages, while numerical variables were expressed as mean and standard deviation. Comparison of variables was done using the chi-square test for categorical variables, the independent student t-test, and one-way analysis of variance for numerical variables. Correlation between variables was done using the Pearson correlation test. Multiple binary logistic regression analysis was performed to detect the predictors of follow-up. $P < 0.05$ was considered significant value at a confidence interval (CI) of 95%.

RESULTS

The present study included 743 subjects; 467 of them aged 25–50 years (62.8%), 192 aged 51–64 years (25.8%), and 84 aged 65 years or more (11.3%). Adult population aged 25–50 years had statistically significant lower serum level of Vitamin D compared to older age groups. Vitamin D deficiency was statistically significant higher among young adults aged 25–50 years, while excess Vitamin D was statistically significant higher frequency among the geriatric age group, as shown in Table 1.

Among our studied population, 323 subjects (43.5%) had abnormal Vitamin D levels (304 with deficient vitamin D and 19 with excess vitamin D). 24% of them (80 subjects) attend back for follow-up (70 with deficient vitamin D and 10 with excess vitamin D). Our findings revealed a high missed follow-up rate of 76%. 9 out of 19 subjects with excess Vitamin D miss follow-up (47.4%) while 234 out of 304 subjects with deficient Vitamin D miss their follow-up (78%). Missing follow-up was statistically significantly higher among those with Vitamin D deficiency than those with excess Vitamin D and among adults than the geriatric age groups. Follow-up rate was significantly higher in the geriatric age group (17 out of 28 subjects; 60.7%) compared to younger age groups; those aged 25–50 years (17.5%; 40 out of 229) and those aged 51–64 years (34.8%; 23 out of 66). Subjects who attend for follow-up has statistically significantly older age than those who missed follow-up as shown in Table 2, Figures 1 and 2.

In the adult age group 25–50 years, 467 were included; 229 have abnormal level of Vitamin D (49%). Only 40 of them (17.5%) attend back for follow-up. On follow-up visit, Vitamin D serum level normalized in 38 patients (95%), 2 patients still have insufficient Vitamin D level (5%). In the adult age group 51–64 years, 192 were included; 66 have abnormal level of Vitamin D (34.4%). Only 23 of them (34.8%) attend back for follow-up. On follow-up visit, Vitamin D serum level normalized in all patients (100%). In the geriatric age group ≥65 years, 84 were included; 28 have abnormal level of Vitamin D (33.4%). Only 17 of them (60.7%) attend back for follow-up. On follow-up visit, Vitamin D serum level normalized in all patients (100%) as shown in Table 3 and Figure 3.

Adjusted multivariable logistic regression for predictors for attendance for follow-up demonestrated that geriatric age group (adjusted odds ratio [aOR] = 6.742, 95% CI: 2.903–15.658; $P = 0.0001$), and middle aged adults (50–64 years old) (aOR = 2.868, 95% CI: 1.139–7.221; $P = 0.025$) and deficient Vitamin D level (aOR = 2.732, 95% CI: 1.006–7.417; $P = 0.049$) were significant independent predictors for attendance for follow-up as shown in Table 4.

DISCUSSION

Identification of vulnerable subjects while still asymptomatic allows early intervention to prevent the development of

Table 1: Clinical characteristics of the studied age groups

Characteristic	All		Age 25–50 years		Age 51–64 years		Age ≥65 years		One-way analysis of variance Chi-square test	
	n=743		n=467		n=192		n=84		f/χ^2	P-value
Sex										
Male	265	35.7%	168	36.0%	66	34.4%	31	36.9%	0.215	0.898
Female	478	64.3%	299	64.0%	126	65.6%	53	63.1%		
Vitamin D category										
Normal Vitamin D	420	56.5%	238	51.0%	126	65.6%	56	66.7%	23.368	<0.0001*
Deficient Vitamin D	304	40.9%	221	**47.3%**	59	30.7%	24	**28.6%**		
Excess Vitamin D	19	2.6%	8	1.7%	7	3.6%	4	4.8%		
Vitamin D level (ng/dL)										
Mean±standard deviation	27.73±12.90		**25.98±12.20**		30.47±13.39		31.19±13.82		11.769	<0.0001*

*Significant. Vitamin D deficiency was statistically significant higher among young adults aged 25–50years (47.3%), while excess Vitamin D was statistically significant higher frequency among the geriatric age group (4.8%).

Table 2: Clinical characteristics of the subjects with abnormal Vitamin D level

Characteristic	All		Follow-up		No follow-up		Independent student T/Chi-square test	
	n=323		n=80		n=243		f/χ^2	*P*-value
Sex								
Male	110	34.1%	26	32.5%	84	34.6%	0.115	0.735
Female	213	65.9%	54	67.5%	159	65.4%		
Vitamin D category								
Deficient	304	94.1%	70	87.5%	234	96.3%	8.411	0.004*
Excessive	19	5.9%	10	12.5%	9	3.7%		
Age (years)								
Mean±standard deviation	43.94±12.21		49.92±13.28		41.97±11.19		5.254	<0.0001*
Age group								
25–50 years	229	70.9%	40	50.0%	189	77.8%	29.567	<0.0001*
51–64 years	66	20.4%	23	28.7%	43	17.7%		
≥65 years	28	8.7%	17	21.3%	11	4.5%		

*Significant

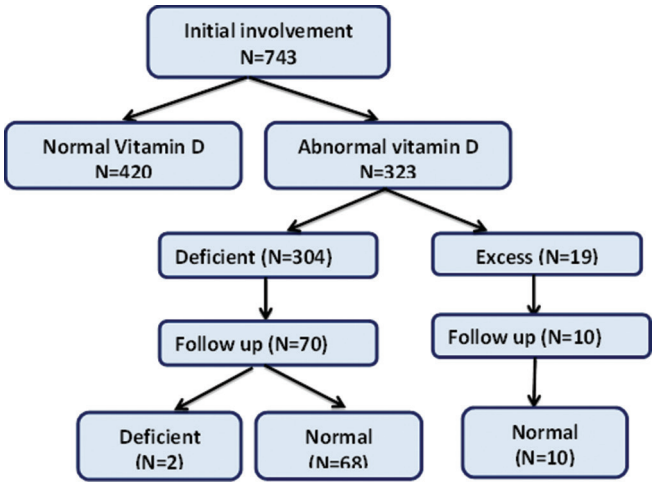

Figure 1: Follow-up chart of the studied population

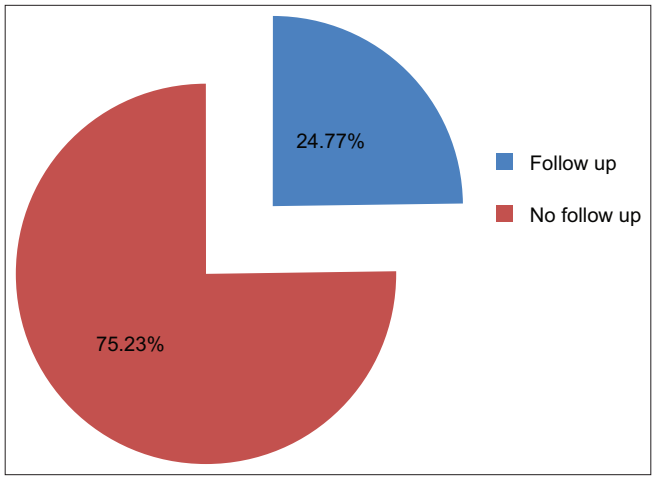

Figure 2: Follow-up rate among subjects with abnormal vitamin D level

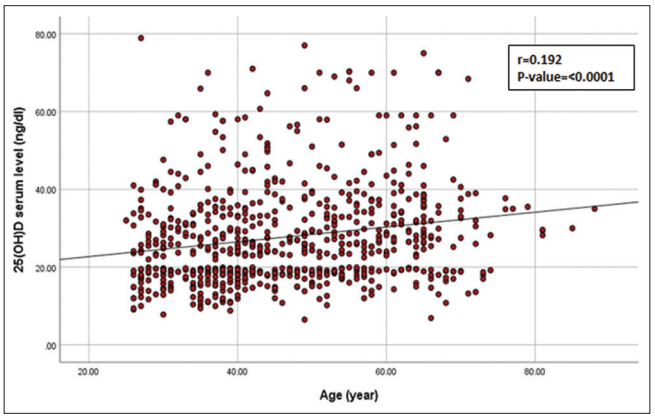

Figure 3: Correlation between vitamin D serum level and age

osteopenia-related complications. Prophylactic interventions, including Vitamin D testing and proper supplementation, should be incorporated in medical practice to enhance both patient and physician awareness and promote effective preventive measures for Vitamin D deficiency in adults and geriatrics. Cholecalciferol supplementation should be tailored individually, considering Serum 25(OH)D level, age, body mass index, sun exposure, dietary habits, and associated medical illness. Regular testing for Vitamin D at each health care visit is not recommended, but attention should be given to explore risk factors of Vitamin D inadequacy, and laboratory testing should be limited to those with inadequate intake or symptomatic. Over-the-counter consumption of Vitamin D supplements should be discouraged. 25(OH) D levels should be maintained above 20 ng/dL in adults and above 30 ng/dL in the geriatric population to avoid the development of hypervitaminosis D.

Our study revealed over all prevalence of Vitamin D deficiency of 40.9% across all age groups, with significant

Table 3: Comparison of follow-up rate in relation to Vitamin D level in each age group

Characteristic	Deficient Vitamin D		Excess Vitamin D		Chi-square test	
					χ^2	*P*-value
25–50 years old (n=229)						
Follow-up rate						
Missed follow-up	183	82.8%	6	75.0%	0.326	0.568
Follow-up	38	17.2%	2	25.0%		
Sex						
Male	76	34.4%	1	12.5%	1.657	0.198
Female	145	65.6%	7	87.5%		
51–64 years old (n=66)						
Follow-up rate						
Missed follow-up	41	69.5%	2	28.6%	4.615	0.032*
Follow-up	18	30.5%	5	71.4%		
Sex						
Male	20	33.9%	3	42.8%	0.221	0.638
Female	39	66.1%	4	57.2%		
65–81 years old (*n*=28)						
Follow-up rate						
Missed follow-up	10	41.7%	1	25.0%	0.399	0.527
Follow-up	14	58.3%	3	75.0%		
Sex						
Male	9	37.5%	1	25.0%	0.233	0.629
Female	15	62.5%	3	75.0%		

*Significant

Table 4: Multiple binary logistic regression analysis for attending follow-up

Characteristic	aOR*	95% CI for aOR		*P*-value
		Lower	Upper	
Age group				
≥65 years versus 25–50 years old	6.742	2.903	15.658	0.0001**
50–64 years versus 25–50 years old	2.868	1.139	7.221	0.025**
Sex (females vs. males)	1.116	0.632	1.972	0.704
Vitamin D level (excess vs. deficient)	2.732	1.006	7.417	0.049**

*Adjusted for age, sex, and Vitamin D level, **significant, CI: Confidence interval, aOR: Adjusted odds ratio

higher frequency of insufficient Vitamin D among young adults aged 25–50 years compared to those of older age. Furthermore, young adults have significant higher rate of missed follow-up visits compared to older age. This reflects the underestimation of the risk and hazards of hypovitaminosis D among the young-aged population. With increased public awareness about the role of Vitamin D in health and disease, vulnerable subjects, including the geriatric age group, postmenopausal females, and individuals with associated medical comorbidities, tend to have a high frequency of medical care visits, thus could explain the significantly higher follow-up rate among the elderly and adults aged above 50 years compared to the younger age group. During medical assessment, checking for Vitamin D dietary intake and laboratory assessment of Vitamin D serum level in such vulnerable groups is greatly expanded as a risk stratification strategy to prevent the development of Vitamin D-related disorders. Encouragement of Vitamin D consumption either from dietary sources or pharmaceutical supplements to fulfill the normal daily requirement attributes to decreased Vitamin D insufficiency with age advance in our studied population.

Similar to our findings, Madkhali *et al.*[11] demonstrated a significant positive correlation between age and 25(OH)D serum level across all ages, with statistically significantly

higher 25(OH)D level among elderly (30.60 ± 15.2) compared to young adults (24.18 ± 13.3). Abdelsalam *et al*.[12] reported Vitamin D insufficiency in younger age (11.7% in those age ≥60 years old, 32.2% in those aged 40–59 years old and 42% in those aged 25–39 years old) and in subjects without associated medical comorbidities that was partially attributed to poor dietary habits among apparently healthy young adults with neglect consumption of Vitamin D-rich foods and lacking of receiving Vitamin D supplements. Wang *et al*.[13] reported frequency of Vitamin D deficiency in young adults (36.7% in those aged 50–59 years, 31.7% in those aged 60–69 years and 29.8% in those aged 70–79 years) with higher frequency of high Vitamin D in elderly (21.8% in those aged 70.79 years, 17.1% in those aged 60–69 years and 12.8% in those aged 50–59 years). Vitamin D level tends to increase with older age, female gender, and higher education. Despite of contradiction in sex predominance in subjects with Vitamin D deficiency, some studies agree with our findings of statistical insignificant difference between both genders.[14,15]

Previous reports from Saudi Arabia and other countries showed a higher prevalence of Vitamin D insufficiency, especially among both adults and the elderly. A meta-analysis explores the global prevalence of Vitamin D deficiency in the elderly demonstrated that the prevalence of Vitamin D deficiency among the Saudi population was 59.7% in the general population and 27.5% in the elderly.[4]

Alzahrani *et al*.[16] reported that among the elderly population aged above 60 years, the prevalence of Vitamin D deficiency was 53.6%, while 29.9% showed insufficient levels of Vitamin D. Hypovitaminosis D was more prevalent among elderly subjects lacking any Vitamin D supplementation compared to those who received Vitamin D supplements (66.1% vs. 38.7%). Despite receiving a Vitamin D supplement, 29% of the elderly still have insufficient Vitamin D levels, reflecting poor compliance, improper dosing regimen, drug interactions, or limited absorption or utilization, indicating the importance of follow-up for such subjects all through the course of treatment to ensure achieving the optimum level. Furthermore, high Vitamin D level exceeding 50 ng/dL was more prevalent among elderly subjects who received Vitamin D supplements than those who did not receive supplements (58% vs. 42%), suggesting overuse of supplements either as excessive dose or prolonged duration. Similar findings were detected in our studied population, but at a lower rate due to the strict follow-up among our subjects.

ALbuloshi *et al*.[17] demonstrated that 63% of elderly populations aged more than 65 years have a deficient level of Vitamin D, with significant higher frequency of deficient Vitamin D in those who did not receive Vitamin D supplements than those who receive supplements (84% vs. 16%). Male gender, sun exposure, and skin pigmentation were predictors for deficient Vitamin D among the elderly population, while physical activity, body mass index, seasonality, associated comorbidities, and socio-demographic variables did not influence Vitamin D status in the geriatric age group. Higher levels of Vitamin D among elderly females may be explained by the higher rate of Vitamin D supplementation among females than males (65% vs. 35%). Other studies revealed a higher frequency of hypovitaminosis D among elderly females compared to males.[18,19]

This contradiction with tends to declined prevalence of Vitamin D deficiency in recent years reflects the debates regarding the cut-off point for Vitamin D deficiency that vary between 20 ng/dL and 30 ng/dL. Our study follows the recommendation of the Endocrine Society that defines Vitamin D level <20 ng/dL as deficiency.[20]

Excess Vitamin D (exceed 60 ng/dL) was significantly higher among the elderly than the younger population. Revising data of such individuals reveals overuse of Vitamin D supplementation either due to over-the-counter prescription without medical advice or due to prolonged use of therapeutic doses of Vitamin D to overcome the risk for developing Vitamin D deficiency. Despite that none of our studied subjects had a toxic level of Vitamin D (>100 ng/dL), our findings give an alarm for insufficient public awareness regarding the hazards of overuse of vitamin supplementation.

Evidences revealed that only 20% of the Vitamin D requirement can be obtained from an ordinary diet; thus, achieving a sufficient level of Vitamin D above 20 ng/mL is hardly to be done through food consumption.[1] Alternative sources include a Vitamin D-fortified diet, which is uncommon in Arab countries. Other alternative includes pharmacological supplements. Guidelines recommend daily Vitamin D intake at a dose ranged from 400 IU to 2000 IU, which is considered safe and effective to prevent the development of Vitamin D deficiency.[21]

On follow-up visit for those with insufficient or excess Vitamin D levels, the majority get a normalized level. This reflects the efficacy of conservative and therapeutic interventions in maintaining adequate Vitamin D. In our center, most patients' follow-up visits were scheduled after 2–3 months of receiving therapeutic Vitamin D doses. Most guidelines did recommend re-testing of the Vitamin D level after receiving treatment. Furthermore, there is a lack of clear recommendations for the timing of follow-up visits for those who receive pharmacological Vitamin D supplementation. Emerging reports of cases with hypervitaminosis D indicate the need for developing guidelines for the timing of follow-up visits for such patients with clear recommendations regarding the indication of re-testing of Vitamin D level.

Gulf regional experts recommend a protective strategy against Vitamin D related bone pathologies through reducing

the risk of developing insufficient Vitamin D. the consensus recommended empirical prescription of Vitamin D without testing for asymptomatic subjects who are at high risk of Vitamin D deficiency, and recommend testing those with high clinical suspicion of Vitamin D deficiency to determine the appropriate Vitamin D dose with minimum interval of 3–6 months before repetition of testing that should not exceed 3 times/year and screening should be targeted for Vitamin D deficiency vulnerable population. For those with severe Vitamin D deficiency, a therapeutic loading dose of 50,000 IU weekly for 6 weeks with an empirical therapeutic daily dose of 800–2000 IU that should not exceed 4000 IU.[22] The Saudi expert consensus recommends maintaining a Vitamin D level equal to 20 ng/mL for the general population and above 30 ng/mL for osteoporotic elderly.[23] Over-the-counter consumption of Vitamin D supplements, irrespective of variation in concentration, intestinal absorption, and bioavailability, may contribute to an excessive rise in serum Vitamin D level.[24]

The retrospective design and incorporation of subjects from a single center, as well as the small number of geriatrics, represent the major limitations of our study. Despite of lacking a local policy for monitoring Vitamin D status among attendances to our center, the present study has a power of exploring the impact of Vitamin D supplementation and follow-up on Vitamin D status in a wide age group extending from young adults to geriatrics.

CONCLUSION

Vitamin D deficiency is still high among all age groups; however, it tends to decline among those older than 50 years who attend for regular health care visits. Missing follow-up among those with abnormal Vitamin D status represents a major challenge during medical practice. Vitamin D testing is a valuable tool for risk stratification of vulnerable groups who are at high risk for Vitamin D insufficiency.

CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

DATA AVAILABILITY

Not applicable.

CODE AVAILABILITY

Not applicable.

AUTHORS' CONTRIBUTIONS

Not applicable.

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DISCLAIMERS

The views expressed in the submitted article are my own and not an official position of the institution or funder.

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