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Vitamin D Level Testing in an Urban Midwest Clinic: To Test or Not to Test?

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Abstract Vitamin D deficiency (VDD) is significantly higher among urban populations in the U.S. Midwest, with African Americans being disproportionately affected. There is ongoing debate surrounding who and how often individuals should be screened for VDD. This study aimed to understand the prevalence of VDD, associated risk factors, and discrepancies in testing at an urban-based internal medicine residency clinic. Data were retrospectively collected on all adult patients seen by the clinic during 2018 and descriptive statistical analysis performed. Among 3976 total patients (mean age: 53 years), 18% (n=698) had vitamin D levels analyzed, with deficiency found in 71% of those tested. Mean age of the tested cohort was 59 years, and women (68%) and African Americans (72%) were found more likely to be tested. Women and patients with certain medical conditions were more likely to be tested (P<0.02 for all) but were not more likely to have VDD. Individuals with a diagnosis of chronic kidney disease were less likely to have VDD (P=0.002). Vitamin D levels typically showed improvement after retesting. A low testing rate could contribute to missed diagnoses. Overall, this study revealed that differences in rate of testing do not necessarily correlate to patients' demographical risk of VDD. Clinicians may benefit from a standardized vitamin D testing protocol. (*J Patient Cent Res Rev.* 2022;9:122-127.)

Keywords vitamin D; vitamin D deficiency; primary care; internal medicine; diagnosis; patient demographics

According to the Centers for Disease Control and Prevention, 8% of the U.S. population has severe vitamin D deficiency (VDD, defined as <12 ng/mL), with African Americans having the highest prevalence of low vitamin D concentration.[1] This high prevalence is attributable to differences in pigmentation, resulting in decreased vitamin D synthesis following ultraviolet light exposure.[2] Multiple epidemiologic reports show that the risks of cancer and depression, as well as infectious, autoimmune, and cardiovascular diseases, are higher when 25-hydroxyvitamin D (25[OH]D) levels are inadequate, specifically, <20 ng/mL (or <50 nmol/L).[3-7] In the National Health and Nutrition Examination Survey (NHANES) from 2005 to 2006, 42% of participants ≥20 years of age had vitamin D levels of <20 ng/mL.[8] Many studies have shown that VDD is significantly higher among urban populations, obese individuals, and in the U.S. Midwest.[9,10] However, there is not strong evidence for causation.[11-13]

VDD treatment is safe, easy, and inexpensive.[14,15] Repletion has led to fall prevention as well as skeletal and extraskeletal benefits.[16] Yet, there is still debate surrounding testing for VDD.[17,18] There is even debate regarding the definition of 25[OH]D deficiency, with a range of 25–80 ng/mL being considered optimal.[18] Experts agree that levels less than 20 ng/mL are detrimental to bone health, but a target goal has yet to be globally accepted.[19,20] The Endocrine Society recommends vitamin D testing in certain at-risk groups such as those with chronic kidney disease (CKD) or malabsorptive disease; however, most societies, including the U.S. Preventive Service Task Force and the American Academy of Family Practitioners (AAFP), explain that there is insufficient data to support or oppose screening for adults.[17,21,22] Despite that, vitamin D testing is the fifth most ordered test in older adults in the United States, and Medicare spent over $286 million on vitamin D testing in 2019, making it that provider's seventh most costly test (in aggregate).[23]

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Multiple factors contribute to asynchrony in vitamin D testing, including lack of nationwide guidelines, local prevalence data reports, and discrepancies in defining VDD. The primary objective of this study was to assess the prevalence of VDD in a high-volume internal medicine residency clinic, its known associated risk factors, and discrepancies in testing among patients receiving a vitamin D test.

METHODS

Following institutional review board approval, a retrospective electronic medical records (EMR) review of data from an internal medicine residency clinic located in Milwaukee, Wisconsin, was conducted. Chart analysis was performed for all adult patients who attended the urban clinic at any point from January 2018 to December 2018, regardless of vitamin D levels status. There were no exclusion criteria. Body mass index values that were recorded as less than 13 kg/m^2 or greater than 100 kg/m^2 were omitted. Patients with more than one vitamin D test completed during the study timeframe were tracked for further analyses to determine if there was improvement in vitamin D level(s). All tests had been ordered by physicians.

Vitamin D levels of 30 ng/ml or above were counted as normal per our clinic's EMR guidelines, while levels below 30 ng/ml were defined as deficient for this study. Due to the debate centered around what counts as deficient, insufficient, or normal, we included levels as high as 30 ng/ml in the deficient category to simplify the results. Not only is 30 ng/ml the cut-off for successful repletion of vitamin D after supplementation, but this cut-off includes deficient and insufficient levels per the AAFP.[24]

Risk factors analyzed included CKD, history of bone fracture, history of alcohol use disorder, and celiac disease. While the Endocrine Society identifies more than 20 disease states/risk factors associated with VDD,[15] to streamline analysis for our study, the authors subjectively selected from that list the most common factors used by our clinic to indicate vitamin D testing. A risk factor was deemed present if coded in the patient's EMR. Similar terminology is used in Tables 1 and 2, in which "indication" refers to chart-based evidence that confirmed each analyzed risk factor. We also looked at the time of year that testing was performed.

Descriptive statistics addressed demographics and characteristics of the patients who did or did not receive a vitamin D test, with the primary goal of determining if there was a particular factor(s) that made someone more likely to be tested. Categorical variables were analyzed using chi-squared or Fisher's exact test, as appropriate. Continuous variables were analyzed using *t*-tests or nonparametric tests based on the distribution of data. All analyses were performed using SAS® 9.4 software (SAS Institute Inc.).

RESULTS

In all, 3976 patients were included in the final analyses. Characteristics of the overall population are summarized in Table 1. Among all charts reviewed, 18% (n=698) had vitamin D levels measured; of those, women (68%) and African Americans (72%) made up the majority. The tested group had an average age of 59 years (vs 53 years for the overall study population). Among all patients, 12% had a prior diagnosis of VDD; of note, 71% of the tests performed in that subgroup showed VDD (Table 2).

When looking at demographics of those tested for VDD, women and individuals diagnosed with bone fracture, alcohol use disorder, celiac disease, or CKD were significantly more likely to be tested for VDD (P<0.02; Table 1). Interestingly, individuals with CKD were less likely to have VDD when tested (24% vs 35% testing negative; P=0.002), despite their increased likelihood to be tested (Table 2). Similarly, 67% of the tested population with no prior documented VDD history were found deficient (P<0.001). Of the 698 patients who were initially tested, 20% (n=144) of them were retested. Of those 144 patients, vitamin D levels in 61 (42%) showed improvement on the second test (Table 3).

DISCUSSION

This study revealed that our physicians are identifying patients at risk for VDD and that the clinic analyzed may have a higher prevalence than the geographic average. More than 71% of individuals who had their vitamin D level tested had VDD, indicating that either clinician suspicion for VDD is often correct or that we may be undertesting patients for VDD. The question therefore arises: Should vitamin D levels be evaluated on a protocol basis with more frequent testing, or is clinician judgment sufficient for testing?

Nationally, African Americans are more likely to have VDD; however, our study results showed that African American patients were not more frequently tested despite their making up much of the clinic's racial demographics. Although there was equivocal testing in our clinic, African Americans were not more likely to have VDD. It is unclear if White individuals in our local geographic region are more likely to have VDD, if African American individuals are less likely to have VDD, or if both groups are equally likely to have VDD. Regardless, our study data did not show a racial disparity in who was tested nor who was deficient, as has been documented in previous studies.[9]

Table 1. Demographics and Comorbidities of Total Eligible Clinic Patients Based on Vitamin D Testing

Demographic/Comorbidity	Overall N=3976	Vitamin D test done		*P**
		No n=3278 (82%)	Yes n=698 (18%)	
Race, n (%)				0.804
African American	2861 (72.0)	2355 (71.8)	506 (72.5)	
Other	68 (1.7)	58 (1.8)	10 (1.4)	
White	1047 (26.3)	865 (26.4)	182 (26.1)	
Ethnicity, n (%)				N/A
Hispanic/Latino Origin	161 (4.1)	130 (4.0)	31 (4.4)	
Not of Hispanic/Latino Origin	3807 (95.8)	3140 (95.8)	667 (95.6)	
Unknown	8 (0.2)	8 (0.2)	0 (0)	
Age in years, mean (SD)	53.0 (16.7)	51.9 (16.7)	58.6 (15.8)	<0.001
BMI in kg/m^2, mean (SD)†	31.6 (8.8)	31.6 (8.9)	32.0 (8.7)	0.234
Gender, n (%)				<0.001
Female	2440 (61.4)	1963 (59.9)	477 (68.3)	
Male	1536 (38.6)	1315 (40.1)	221 (31.7)	
Hx of bone fracture, n (%)				0.004
No indication	3740 (94.0)	3100 (94.6)	640 (91.7)	
Indication	236 (5.9)	178 (5.4)	58 (8.3)	
Hx of alcohol use disorder, n (%)				0.0089
No indication	3780 (95.1)	3130 (95.5)	650 (91.1)	
Indication	196 (4.9)	148 (4.5)	48 (6.9)	
Celiac disease, n (%)				0.019
No indication	3966 (99.8)	3273 (99.9)	693 (99.3)	
Indication	10 (0.3)	5 (0.2)	5 (0.7)	
Hx of vitamin D deficiency, n (%)				<0.001
No indication	3499 (88.0)	3036 (92.6)	463 (66.3)	
Indication	477 (12.0)	242 (7.4)	235 (33.7)	
Chronic kidney disease, n (%)				<0.001
No indication	3477 (87.5)	2969 (90.6)	508 (72.8)	
Indication	499 (12.6)	309 (9.4)	190 (27.2)	
Season first vitamin D test done, n (%)				
Winter	296 (7.4)		296 (42.4)	
Spring	124 (3.1)		124 (17.8)	
Summer	176 (4.4)		176 (25.2)	
Fall	102 (2.6)		102 (14.6)	

**All comparisons were done with chi-squared tests.*

†Due to missing values and outliers, n=3947 for BMI analysis.

BMI, body mass index; Hx = history; SD, standard deviation.

Table 1 shows that, indeed, clinical risk factors might be driving physicians' decisions on testing. Although there were significant differences in demographics in who was more likely to be tested, there were no differences in VDD among these groups. An exception to this finding, patients with CKD were less likely to have VDD when compared to someone without that diagnosis. This was surprising given that patients with CKD tend to be at higher risk for VDD.[25] This anomaly could be attributed to the fact that patients with CKD are likely to be following up with a nephrologist who regularly checks and treats VDD.[26] Going forward, collaboration between nephrologists and primary care providers could better identify need for testing and protocols for treatment.

Table 2. Comparison of VDD According to Known Risk Factors Based on Vitamin D Test

Risk factor	Overall N=698	VDD based on tests		*P**
		No VDD n=204 (29%)	Yes VDD n=494 (71%)	
Race, n (%)				0.464
African American	506 (72.5)	143 (70.1)	363 (73.5)	
Other	10 (1.4)	2 (1.0)	8 (1.6)	
White	182 (26.1)	59 (28.9)	123 (24.9)	
Gender, n (%)				0.643
Female	477 (68.3)	142 (69.6)	335 (67.8)	
Male	221 (31.7)	62 (30.4)	159 (32.2)	
Hx of bone fracture, n (%)				0.234
No indication	640 (91.7)	191 (93.6)	449 (90.9)	
Indication	58 (8.3)	13 (6.4)	45 (9.1)	
Hx of alcohol use disorder, n (%)				0.735
No indication	650 (93.1)	191 (93.6)	459 (92.9)	
Indication	48 (6.9)	13 (6.4)	35 (7.1)	
Celiac disease, n (%)				0.329
No indication	693 (99.3)	204 (100.0)	489 (99.0)	
Indication	5 (0.7)	0 (0)	5 (1.0)	
Hx of vitamin D deficiency, n (%)				0.559
No indication	463 (66.3)	132 (64.7)	331 (67.0)	
Indication	235 (33.7)	72 (35.3)	163 (33.0)	
Chronic kidney disease, n (%)				0.002
No indication	508 (72.8)	132 (64.7)	376 (76.1)	
Indication	190 (27.2)	72 (35.3)	118 (23.9)	
Season first vitamin D test done, n (%)				0.885
Winter	296 (42.4)	88 (43.1)	208 (42.1)	
Spring	124 (17.8)	35 (17.2)	89 (18.0)	
Summer	176 (25.2)	54 (26.5)	122 (24.7)	
Fall	102 (14.6)	27 (13.2)	75 (15.2)	

**All comparisons were done with chi-squared tests.*

Hx = history; VDD, vitamin D deficiency.

If a patient had their vitamin D levels retested, they were likely to show improvement (Table 3). Either supplementation or variance in vitamin D levels could be attributable for this positive change.[24] Of note, a mere 1 out of 5 patients were retested. Because of this, it is difficult to make any recommendations on the necessity or frequency for retesting, but an interesting prospective study could stratify individuals with VDD into groups, with variations on testing frequency identifying if more frequent testing led to sufficient vitamin D levels.

Clinicians would benefit from more standardized testing protocols to hopefully detect more VDD. Three reasons our internal medicine residency clinicians may be more likely to test for VDD than the national average are 1) they practice at an academic clinic, that is 2) located in the Midwest, and 3) serves primarily African American patients. Although our data did not show racial differences in VDD, it has been previously reported.[9] Our study was not designed with the intent to include a preponderance of African Americans, the location of the clinic and the local demographics resulted in this shift.

There are several limitations to our study, including a short 1-year collection period, its single-center setting, and the nature of retrospective selection bias, thus results may not be wholly generalizable. In additional, the data were observational and thus there can be no claims made

Table 3. Change in Vitamin D Level per Retesting

Vitamin D level from first to second test	No VDD on test 1, n=204	Positive for VDD on test 1, n=494
No second test done, n (%)	176 (86.3)	378 (76.5)
Decreased, n (%)	0 (0)	15 (3.0)
Increased, n (%)	0 (0)	61 (12.4)
Stayed the same, n (%)	28 (13.7)	40 (8.1)

VDD, vitamin D deficiency.

on clinical implications of testing. Future areas of work include creating a prospective study in which standards are set for individuals to be tested for VDD.[21] This could lead to more objective data about the prevalence of VDD in our clinic as well as better elucidate who needs to be tested.

Overall, better guidelines to measure and treat vitamin D deficiency are needed to prevent health care disparities and general undertesting as well as to more efficiently identify individuals more likely to benefit from supplementation.

Patient-Friendly Recap

- Low vitamin D level is a common nutritional deficiency among Americans, especially those with darker complexions who live in the sun-deprived Midwest.
- This study showed that vitamin D levels often improved upon retesting, indicating treatment — typically a low-cost supplement — was effective.
- Because primary care practices, at present, struggle to proactively identify those individuals likely to have vitamin D deficiency, patients may want to consider discussing vitamin D testing options with their physicians.

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Author Contributions

Study design: all authors. Data acquisition or analysis: all authors. Manuscript drafting: Mundt, Klumph, Heslin. Critical revision: Mundt, Klumph, Heslin.

Conflicts of Interest

None.

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