

MEDICAL POLICY – 2.04.507

Testing Serum Vitamin D Levels

BCBSA Ref Policy: 2.04.135

Effective Date: Mar. 1, 2024

Last Revised: Feb. 12, 2024


Replaces: 2.04.135

RELATED MEDICAL POLICIES:

None

Select a hyperlink below to be directed to that section.

[POLICY CRITERIA](#) | [CODING](#) | [RELATED INFORMATION](#)
[EVIDENCE REVIEW](#) | [REFERENCES](#) | [HISTORY](#)

 Clicking this icon returns you to the hyperlinks menu above.

Introduction

Vitamin D is an important nutrient for maintaining good health. It is especially important for good bone health and calcium metabolism. Many studies and articles have been published in scientific journals and in lay magazines about the benefits of vitamin D. Despite all of this interest, there is very little data about optimal levels of vitamin D, and most published studies are of low quality. The endocrine society and public health experts strongly recommend against measuring vitamin D levels in healthy individuals. Vitamin D is found in some foods, has been added to other foods (cereals and milk), and is increased with exposure to the sun. The U.S. National Institutes of Health (NIH) has recommended vitamin D supplementation for Americans based on age (600 IU per day for ages 1 to 70 years of age). Testing for vitamin D levels is covered when a person has signs or symptoms of vitamin D deficiency or risk factors for vitamin D deficiency.

Claims for vitamin D tests are reviewed after submission based on the diagnosis listed. The diagnoses considered medically necessary and that are covered are listed in this medical policy.

Note: The Introduction section is for your general knowledge and is not to be taken as policy coverage criteria. The rest of the policy uses specific words and concepts familiar to medical professionals. It is intended for providers. A provider can be a person, such as a doctor, nurse, psychologist, or dentist. A provider also can be a place where medical care is given, like a hospital, clinic, or lab. This policy informs them about when a service may be covered.

Policy Coverage Criteria

Testing Condition	Medical Necessity
Asymptomatic	<p>Testing vitamin D levels is considered medically necessary for asymptomatic individuals when:</p> <ul style="list-style-type: none"> • The individual has risk factors for vitamin D deficiency: <ul style="list-style-type: none"> ○ Chronic kidney disease, stage ≥ 3 ○ Cirrhosis/chronic liver disease ○ Malabsorption states (e.g., cystic fibrosis, inflammatory bowel disease, Crohn’s disease, bariatric surgery, radiation enteritis, short bowel syndrome, pancreatitis, amyloidosis, celiac sprue) ○ Osteomalacia ○ Osteoporosis ○ Rickets ○ Hypo- or hyper-calcemia ○ Granulomatous diseases (e.g., sarcoidosis, tuberculosis, histoplasmosis, coccidiomycosis, berylliosis) ○ Vitamin D deficiency, on replacement ○ Obstructive jaundice/biliary tract disease ○ Osteogenesis imperfecta ○ Osteosclerosis/osteopetrosis ○ Chronic use of anticonvulsant medication or corticosteroids ○ Parathyroid disorders ○ Osteopenia • The individual is institutionalized (see Definition of Terms) <p>Testing vitamin D levels is considered not medically necessary for asymptomatic individuals when criteria in this policy are not met.</p>

Testing Condition	Medical Necessity
Symptomatic = Vitamin D Deficiency	Testing vitamin D levels may be considered medically necessary when the individual presents with signs and symptoms of vitamin D deficiency.



Testing Condition	Medical Necessity
	<ul style="list-style-type: none"> • Signs and symptoms of vitamin D deficiency are largely manifested by changes in bone health and biochemical markers associated with bone production and resorption. <ul style="list-style-type: none"> ○ In most cases, a clinical diagnosis of an abnormality in bone health (e.g., rickets, osteomalacia, osteoporosis) will lead to a decision to test vitamin D levels. ○ Symptoms related to the clinical condition may be present, such as pain or low-impact fractures, but these symptoms are usually not indications for testing prior to a specific diagnosis. ○ Some biochemical markers of bone health may indicate an increased risk for vitamin D deficiency, as such testing of vitamin D levels may therefore be appropriate. These biochemical markers include unexplained abnormalities in serum calcium, phosphorous, alkaline phosphatase, and/or parathyroid hormone.
Symptomatic = Vitamin D Toxicity (hypervitaminosis D)	<p>Testing vitamin D levels may be considered medically necessary when the individual presents with signs and symptoms of vitamin D toxicity (hypervitaminosis D).</p> <ul style="list-style-type: none"> • Signs and symptoms of vitamin D toxicity generally result from induced hypercalcemia. <ul style="list-style-type: none"> ○ Acute intoxication can cause symptoms of confusion, anorexia, vomiting, weakness, polydipsia, and polyuria. ○ Chronic intoxication can cause bone demineralization, kidney stones, and bone pain.
Repeat testing	<p>A repeat test may be appropriate to determine whether supplementation has been successful in restoring normal serum levels when the initial test was for a medically necessary indication (as noted above).</p> <p>More than 1 repeat test may be indicated in cases where supplementation has not been successful in restoring levels, documented by continued or recurrent signs and symptoms (as noted above), which may indicate ongoing deficiency, and/or inadequate absorption.</p>



Coding

The following codes are specific to vitamin D testing and related to medically necessary diagnoses:

Code	Descriptor
CPT	
0038U	Vitamin D, 25 hydroxy D2 and D3, by LC-MS/MS, serum microsample, quantitative
82306	Vitamin D; 25 hydroxy, includes fraction(s), if performed
82652	Vitamin D; 1, 25 dihydroxy, includes fraction(s), if performed
ICD-10 Diagnosis Codes - Covered	
A15.0	Tuberculosis
A28.1	Cat-scratch disease
B20	Human immunodeficiency virus (HIV) disease
B38.0-B38.9	Coccidiomycosis
B39.0-B39.9	Histoplasmosis
B41.0	Pulmonary paracoccidioidomycosis
B41.7	Disseminated paracoccidioidomycosis
B41.9	Paracoccidioidomycosis, unspecified
B59	Pneumocystosis
D71	Functional disorders of polymorphonuclear neutrophils
D86.0 – D86.9	Sarcoidosis
E05.00 – E05.91	Thyrotoxicosis
E20.0 – E20.9	Hypoparathyroidism, code range
E21.0 – E21.5	Hyperparathyroidism and other disorders of parathyroid gland
E41	Nutritional marasmus
E43	Unspecified severe protein-calorie malnutrition
E55.0; E55.9	Vitamin D deficiency codes
E67.3	Hypervitaminosis D
E72.0 – E72.09	Disorders of amino-acid transport, unspecified



Code	Descriptor
E74.21	Galactosemia
E83.30 – E83.39	Disorder of phosphorus metabolism
E83.50 – E83.59	Disorder of calcium metabolism
E84.0-E84.9	Cystic fibrosis
E85.0-E85.9	Amyloidosis
E89.2	Postprocedural hypoparathyroidism
J63.2	Berylliosis
K50.00-K50.919	Crohn disease
K51.00-K51.919	Inflammatory bowel disease
K52.0	Radiation enteritis
K70.0 – K77	Disorders of the liver, code range
K83.1 – K83.9	Other diseases of biliary tract
K86.0-K86.9	Pancreatitis
K90.0 – K90.9	Intestinal malabsorption, code range
K91.2	Postsurgical malabsorption, not elsewhere classified
L92.0 – L92.9	Granulomatous disorders of skin and subcutaneous tissue
M80.00 – M81.8	Osteoporosis, code range
M83.0 – M83.9	Osteomalacia, code range
M85.80 – M85.9	Other specified disorders of bone density and structure
M88.0	Osteitis deformans of skull
M88.1	Osteitis deformans of vertebrae
M88.811	Osteitis deformans of right shoulder
M88.812	Osteitis deformans of left shoulder
M88.821	Osteitis deformans of right upper arm
M88.822	Osteitis deformans of left upper arm
M88.831	Osteitis deformans of right forearm



Code	Descriptor
M88.832	Osteitis deformans of left forearm
M88.841	Osteitis deformans of right hand
M88.842	Osteitis deformans of left hand
M88.851	Osteitis deformans of right thigh
M88.852	Osteitis deformans of left thigh
M88.861	Osteitis deformans of right lower leg
M88.862	Osteitis deformans of left lower leg
M88.871	Osteitis deformans of right ankle and foot
M88.872	Osteitis deformans of left ankle and foot
M88.88	Osteitis deformans of other bones
M88.89	Osteitis deformans of multiple sites
M88.9	Osteitis deformans of unspecified bone
N18.1 – N18.9	Chronic kidney disease (CKD), code range
N20.0 – N20.9	Calculus of kidney and ureter
N22	Calculus of urinary tract in diseases classified elsewhere
N25.81	Secondary hyperparathyroidism of renal origin
P71.0 – P71.9	Transitory neonatal disorders of calcium and magnesium metabolism
Q78.0	Osteogenesis imperfecta
Q78.2	Osteopetrosis
R17	Unspecified jaundice
Z79.51	Long term (current) use of inhaled steroids
Z79.52	Long term (current) use of systemic steroids
Z79.899	Other long term (current) drug therapy
Z94.0-Z94.9	Transplanted organ and tissue status [medications known to reduce vitamin D]
Z98.0	Intestinal bypass and anastomosis status
Z98.84	Bariatric surgery



Related Information

Definition of Terms

Institutionalized: For the purposes of this policy, “institutionalized” refers to individuals who reside at long-term care facilities where some degree of medical care is provided. These circumstances and facilities can include long-term hospital stays, nursing homes, assisted living facilities, and similar environments.

Benefit Application

Consistent with federal mandates, vitamin D supplements are covered as preventive care for individuals age 65 and older (without cost sharing) when the member’s contract is subject to those mandates. A written prescription is needed for coverage.

The USPSTF recommends exercise or physical therapy and vitamin D supplementation to prevent falls in community-dwelling adults aged 65 years or older who are at increased risk for falls. (Grade B recommendation)

Note: The USPSTF does not recommend routine testing of vitamin D levels as a preventive strategy (see [Practice Guidelines and Position Statements](#)).

Evidence Review

Description

Vitamin D, also known as calciferol, is a fat-soluble vitamin that has a variety of physiologic effects, most prominently in calcium homeostasis and bone metabolism. In addition to the role it plays in bone metabolism, other physiologic effects include inhibition of smooth muscle proliferation, regulation of the renin-angiotensin system, a decrease in coagulation, and a decrease in inflammatory markers.¹



Background

Vitamin D

Vitamin D deficiency is best assessed by measuring serum levels of 25-hydroxyvitamin D. However, there is no consensus on the minimum vitamin D level or on the optimal serum level for overall health. A 2011 Institute of Medicine (IOM) report concluded that a serum level of 20 ng/mL is sufficient for most healthy adults.² Some experts, such as the Bone Health and Osteoporosis Foundation (formerly the National Osteoporosis Foundation) have recommend a higher level (30 ng/mL) in some individual populations.³

Vitamin D deficiency, as defined by suboptimal serum levels, is common in the US. In the National Health and Nutrition Examination Survey covering the period of 2011 to 2014, 5% of patients aged 1 year and older were at risk of vitamin D deficiency (25-hydroxyvitamin D levels <12 ng/mL) and 18.3% of patients were at risk of vitamin D inadequacy (25-hydroxyvitamin D levels 12 to 19.6 ng/mL).⁴ Vitamin D deficiency occurs most commonly as a result of inadequate dietary intake coupled with inadequate sun exposure. Evidence from the National Nutrition Monitoring System and the National Health and Nutrition Examination Survey has indicated that the average vitamin D consumption is below recommended levels of intake. Yetley (2008) estimated that average daily intake for US adults ranged from 228 to 335 IU/d, depending on gender and ethnicity.⁵ This level is below the average daily requirement, estimated by IOM (400 IU/d for healthy adults) and well below IOM's required daily allowance (estimated to be 600 IU for nonelderly adults and 800 IU for elderly adults).

Vitamin D deficiency may occur less commonly for other reasons. Kidney or liver disease can cause deficiency as a result of impaired conversion of inactive vitamin D to its active products. In rare situations, there is vitamin D resistance at the tissue level, which causes a functional vitamin D deficiency despite "adequate" serum levels.

The safe upper level for serum vitamin D is also not standardized. The IOM report concluded that there is potential harm associated with levels greater than 50 ng/mL and recommended that serum levels be maintained in the 20- to 40-ng/mL range.² However, conclusions on this point have differed. A 2011 Agency for Healthcare Research and Quality (AHRQ) systematic review on vitamin D and bone health concluded that "There is little evidence from existing trials that vitamin D above current reference intakes is harmful."⁶ The Women's Health Initiative concluded that hypercalcemia and hypercalciuria in patients receiving calcium and vitamin D were not associated with adverse clinical events.⁷ The Women's Health Initiative did find a small increase in kidney stones for women aged 50 to 79 years who received vitamin D and calcium.



Associations of vitamin D levels with various aspects of health have been noted over the last several decades,⁸⁻¹² and these findings have led to the question of whether supplementation improves health outcomes. For example, a relation between vitamin D levels and overall mortality has been reported in most observational studies examining this association.^{13,14} Mortality is lowest at vitamin D levels in the 25- to 40-nmol/L range. At lower levels of serum vitamin D, mortality increases steeply, and overall mortality in the lowest quintile was more than three times that in the middle quintiles. Theodoratou et al (2014) identified 107 systematic reviews of observational studies examining the association between vitamin D levels and more than 100 different outcomes.¹⁵

Vitamin D Replacement

The Institute of Medicine (IOM) (now the National Academy of Medicine [NAM]) has recommended reference values for intake of vitamin D and serum levels, based on available literature and expert consensus.² Recommended daily allowances are 600 IU/d for individuals between 1 and 70 years of age and 800 IU/d for individuals older than 70 years.

Estimates of vitamin D requirements are complicated by the many other factors that affect serum levels. Sun exposure is the most prominent of factors that affect serum levels, and this is because individuals can meet their vitamin D needs entirely through adequate sun exposure. Other factors such as age, skin pigmentation, obesity, physical activity, and nutritional status also affect vitamin D levels and can result in variable dietary intake requirements to maintain adequate serum levels.

Excessive intake of vitamin D can be toxic. Toxic effects are usually due to hypercalcemia and may include confusion, weakness, polyuria, polydipsia, anorexia, and vomiting. In addition, high levels of vitamin D may promote calcium deposition and has the potential to exacerbate conditions such as calcium kidney stones and atherosclerotic vascular disease.

The IOM defined three parameters of nutritional needs for vitamin D, on the assumption of minimal sun exposure. These parameters were the estimated average requirement, defined as the minimum intake required to maintain adequate levels; the recommended daily allowance, defined as the optimal dose for replacement therapy; and the upper-level intake, defined as the maximum daily dose to avoid toxicity. These recommendations are summarized in [Table 1](#).



Table 1. Institute of Medicine Recommendations for Vitamin D Dietary Intake²

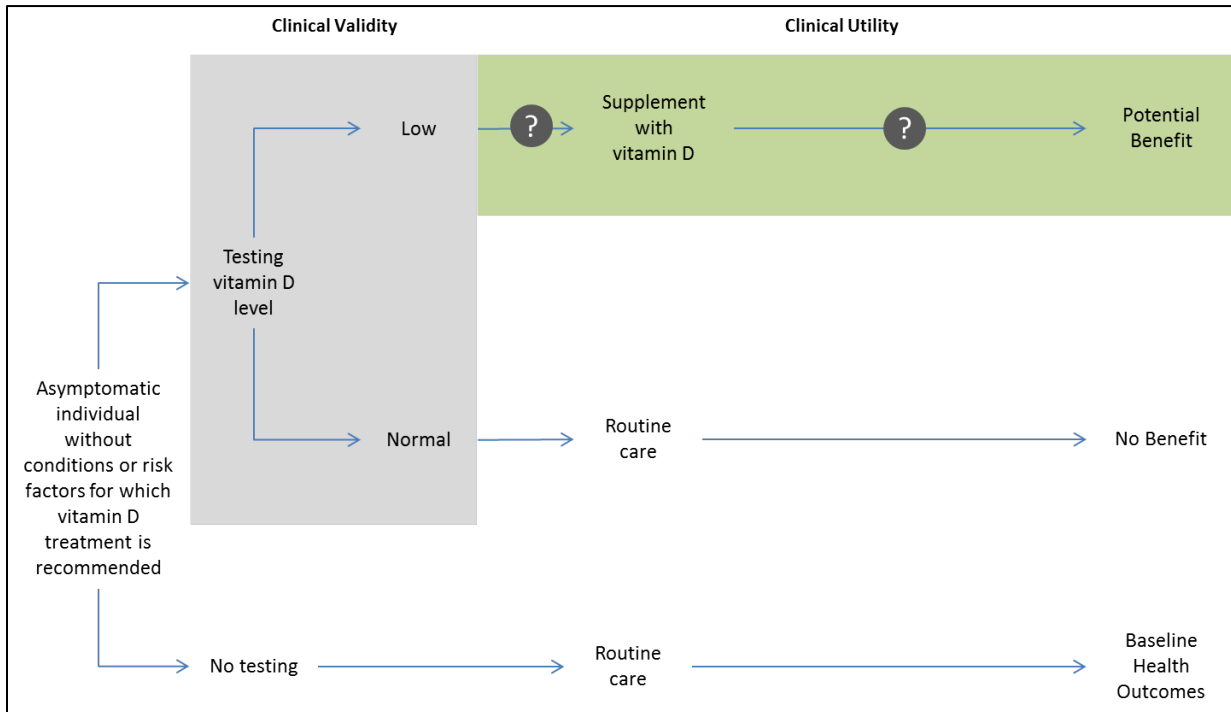
Patient Group	Estimated Average Requirement, IU/d	Recommended Daily Allowance, IU/d	Upper Limit Intake, IU/d
1 to 3 years old	400	600	2500
4 to 8 years old	400	600	3000
9 to 70 years old	400	600	4000
>70 years old	400	800	4000

Adapted from Institute of Medicine (2011)²

Analytic Framework

Figure 1 summarizes the approach to this policy. The diagram demonstrates the framework for how vitamin D testing affects outcomes. Using this framework, the main question is whether testing individuals for vitamin D deficiency improves outcomes.

Figure 1. Analytic Framework



Based on this analytic framework, the most relevant studies for showing the clinical utility of vitamin D testing are trials that directly compare care including testing vitamin D levels against care without testing vitamin D levels. Should vitamin D screening in an asymptomatic, general population be shown to be effective, guidelines would then be needed to establish criteria for screening, screening intervals, and appropriate follow-up for positive tests. Indirect evidence of the utility of vitamin D testing would include evidence of the effectiveness of supplementation from trials testing supplementation to no supplementation in individuals who are vitamin D deficient. Many of the existing randomized controlled trials (RCTs), including the largest trial (Women's Health Initiative), did not test vitamin D levels prior to treatment. Rather, they treated all individuals enrolled regardless of vitamin D levels. Results of some of the main systematic reviews that take this approach will be reviewed, but this evidence is indirect and must be extrapolated from the treatment of all individuals to treatment of individuals who are vitamin D deficient.

Summary of Evidence

For individuals who are asymptomatic without conditions or risk factors for which vitamin D treatment is recommended who receive testing of vitamin D levels, the evidence includes no randomized controlled trials (RCTs) of clinical utility (i.e., evidence that patient care including testing vitamin D levels vs care without testing vitamin D levels improves outcomes). The relevant outcomes are overall survival, test validity, symptoms, morbid events, and treatment-related morbidity. Indirect evidence of the potential utility of testing includes many RCTs and systematic reviews of vitamin D supplementation. There is a lack of standardized vitamin D testing strategies and cutoffs for vitamin D deficiency are not standardized or evidence-based. In addition, despite the large quantity of evidence, considerable uncertainty remains about the beneficial health effects of vitamin D supplementation. Many RCTs have included participants who were not vitamin D deficient at baseline and did not stratify results by baseline 25-hydroxyvitamin D level. Nonwhite race/ethnic groups are underrepresented in RCTs but have an increased risk of vitamin D deficiency. For skeletal health, there may be a small effect of vitamin D supplementation on falls, but there does not appear to be an impact on reducing fractures for the general population. The effect on fracture reduction may be significant in elderly women, and with higher doses of vitamin D. However, high doses of vitamin D may be associated with safety concerns in individuals at risk for falls. For individuals with asthma, there may be a reduction in severe exacerbations with vitamin D supplementation, but there does not appear to be an effect on other asthma outcomes. For individuals who are pregnant, vitamin D supplementation may improve maternal and fetal outcomes. For overall mortality, there is also no benefit to the general population. RCTs evaluating extraskeletal, cancer, cardiovascular, and



multiple sclerosis outcomes have not reported a statistically significant benefit for vitamin D supplementation. Although vitamin D toxicity and adverse events appear to be rare, few data on risks have been reported. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Ongoing and Unpublished Clinical Trials

Some currently ongoing and unpublished trials that might influence this review are listed in [Table 2](#).

Table 2. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT05431920	Effects of Vitamin D3 Supplementation in Asthma Control, Pulmonary Function and Th17 Inflammatory Biomarkers in Adolescents With Asthma, Obesity and Vitamin D Deficiency: a Randomized Clinical Trial	264	Aug 2024
NCT05043116	High-dose Vitamin D Supplement for the Prevention of Acute Asthma-like Symptoms in Preschool Children - a Double-blind, Randomized, Controlled Trial	320	Oct 2031
NCT05329428	PREDIN: Pregnancy and Vitamin D Intervention Study - A Randomized Controlled Trial	102	Dec 2024
NCT05208827	A Multicenter Randomized Controlled Study of Vitamin D Supplementation in Pregnant Women for the Prevention of Gestational Diabetes.	1600	Jan 2025
NCT04291313	Vitamin D Deficiency in Pregnancy - Identifying Associations and Mechanisms Linking Maternal Vitamin D Deficiency to Placental Dysfunction and Adverse Pregnancy Outcomes	2000	May 2023
NCT00856947	Vitamin D Supplementation During Pregnancy for Prevention of Asthma in Childhood: An Interventional Trial in the ABC (Asthma Begins in Childhood) Cohort	600	Jul 2027
Unpublished			



NCT No.	Trial Name	Planned Enrollment	Completion Date
NCT04117581	A Daily 5000 IU Vitamin D Supplement for the Improvement of Lung Function and Asthma Control in Adults With Asthma: a Randomised Controlled Trial	32 (actual)	Apr 2022

NCT: national clinical trial

Practice Guidelines and Position Statements

The purpose of the following information is to provide reference material. Inclusion does not imply endorsement or alignment with the policy conclusions.

Guidelines or position statements will be considered for inclusion if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American College of Obstetrics and Gynecology

The American College of Obstetrics and Gynecology (2011, reaffirmed 2021) issued a committee opinion on the testing of vitamin D levels and vitamin D supplementation in pregnant women.¹²¹ The following recommendation was made concerning testing vitamin D levels:

“At this time there is insufficient evidence to support a recommendation for screening all pregnant women for vitamin D deficiency. For pregnant women thought to be at increased risk of vitamin D deficiency, maternal serum 25-hydroxyvitamin D levels can be considered and should be interpreted in the context of the individual clinical circumstance. When vitamin D deficiency is identified during pregnancy, most experts agree that 1,000-2,000 international units per day of vitamin D is safe.”

Bone Health and Osteoporosis Foundation

The Bone Health and Osteoporosis Foundation updated recommendations for the prevention and treatment of osteoporosis in 2021.³ They recommended monitoring serum 25-hydroxy



vitamin D levels in postmenopausal women and men 50 years of age and older, and vitamin D supplementation as necessary to maintain levels between 30 and 50 ng/mL.

Endocrine Society

In 2011, the Endocrine Society published clinical practice guidelines on the evaluation, treatment and prevention of vitamin D deficiency.¹²² The following recommendations were made regarding testing vitamin D levels:

- 25-hydroxyvitamin D serum level testing is recommended “to evaluate vitamin D status only in patients who are at risk of deficiency.” The guideline did not recommend screening of individuals not at risk of vitamin D deficiency.
- 1,25-dihydroxyvitamin D testing is not recommended to evaluate vitamin D status. However, the guideline did recommend monitoring calcitriol levels in certain conditions.

U.S. Preventive Services Task Force Recommendations

The US Preventive Services Task Force published an updated recommendation¹²³, and associated evidence report and systematic review in 2021¹²⁴ on vitamin D screening. The Task Force concluded that the current evidence was insufficient to assess the balance of benefits and harms of screening for vitamin D deficiency in asymptomatic individuals (grade I [insufficient evidence]).

Medicare National Coverage

There is no national coverage determination.

Regulatory Status

The US Food and Drug Administration (FDA) has cleared a number of immunoassays for in vitro diagnostic devices for the quantitative measurement of total 25-hydroxyvitamin D through the 510(k) process.



Clinical laboratories may develop and validate tests in-house and market them as a laboratory service; laboratory-developed tests must meet the general regulatory standards of the Clinical Laboratory Improvement Amendments (CLIA). Lab tests for vitamin D are available under the auspices of the CLIA. Laboratories that offer laboratory-developed tests must be licensed by the CLIA for high-complexity testing. To date, the FDA has chosen not to require any regulatory review of this test.

References

1. Shapses SA, Manson JE. Vitamin D and prevention of cardiovascular disease and diabetes: why the evidence falls short. *JAMA*. Jun 22 2011; 305(24): 2565-6. PMID 21693745
2. Committee to Review Dietary Reference Intakes for Vitamin D and Calcium, Food and Nutrition Board. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: National Academies Press; 2011.
3. LeBoff MS, Greenspan SL, Insogna KL, et al. The clinician's guide to prevention and treatment of osteoporosis. *Osteoporos Int*. Oct 2022; 33(10): 2049-2102. PMID 35478046
4. Herrick KA, Storandt RJ, Afful J, et al. Vitamin D status in the United States, 2011-2014. *Am J Clin Nutr*. Jul 01 2019; 110(1): 150-157. PMID 31076739
5. Yetley EA. Assessing the vitamin D status of the US population. *Am J Clin Nutr*. Aug 2008; 88(2): 558S-564S. PMID 18689402
6. Cranney A, Horsley T, O'Donnell S, et al. Effectiveness and Safety of Vitamin D in Relation to Bone Health (Evidence Reports/Technology Assessments No. 158). Rockville, MD: Agency for Healthcare Research and Quality; 2011.
7. Jackson RD, LaCroix AZ, Gass M, et al. Calcium plus vitamin D supplementation and the risk of fractures. *N Engl J Med*. Feb 16 2006; 354(7): 669-83. PMID 16481635
8. Holvik K, Ahmed LA, Forsmo S, et al. Low serum levels of 25-hydroxyvitamin D predict hip fracture in the elderly: a NOREPOS study. *J Clin Endocrinol Metab*. Aug 2013; 98(8): 3341-50. PMID 23678033
9. Cauley JA, Lacroix AZ, Wu L, et al. Serum 25-hydroxyvitamin D concentrations and risk for hip fractures. *Ann Intern Med*. Aug 19 2008; 149(4): 242-50. PMID 18711154
10. Mithal A, Wahl DA, Bonjour JP, et al. Global vitamin D status and determinants of hypovitaminosis D. *Osteoporos Int*. Nov 2009; 20(11): 1807-20. PMID 19543765
11. Cauley JA, Parimi N, Ensrud KE, et al. Serum 25-hydroxyvitamin D and the risk of hip and nonspine fractures in older men. *J Bone Miner Res*. Mar 2010; 25(3): 545-53. PMID 19775201
12. Looker AC, Mussolino ME. Serum 25-hydroxyvitamin D and hip fracture risk in older U.S. white adults. *J Bone Miner Res*. Jan 2008; 23(1): 143-50. PMID 17907920
13. Jia X, Aucott LS, McNeill G. Nutritional status and subsequent all-cause mortality in men and women aged 75 years or over living in the community. *Br J Nutr*. Sep 2007; 98(3): 593-9. PMID 17442130
14. Visser M, Deeg DJ, Puts MT, et al. Low serum concentrations of 25-hydroxyvitamin D in older persons and the risk of nursing home admission. *Am J Clin Nutr*. Sep 2006; 84(3): 616-22; quiz 671-2. PMID 16960177
15. Theodoratou E, Tzoulaki I, Zgaga L, et al. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ*. Apr 01 2014; 348: g2035. PMID 24690624



16. DEQAS (Vitamin D External Quality Assurance Scheme). n.d.; <http://www.deqas.org/>. Accessed January 9, 2024.
17. LeBlanc ES, Zakher B, Daeges M, et al. Screening for vitamin D deficiency: a systematic review for the U.S. Preventive Services Task Force. *Ann Intern Med*. Jan 20 2015; 162(2): 109-22. PMID 25419719
18. Ling Y, Xu F, Xia X, et al. Vitamin D supplementation reduces the risk of fall in the vitamin D deficient elderly: An updated meta-analysis. *Clin Nutr*. 2021;40(11):5531-5537. doi:10.1016/j.clnu.2021.09.031
19. Avenell A, Gillespie WJ, Gillespie LD, et al. Vitamin D and vitamin D analogues for preventing fractures associated with involutional and post-menopausal osteoporosis. *Cochrane Database Syst Rev*. Apr 15 2009; (2): CD000227. PMID 19370554
20. Bischoff-Ferrari HA, Willett WC, Wong JB, et al. Prevention of nonvertebral fractures with oral vitamin D and dose dependency: a meta-analysis of randomized controlled trials. *Arch Intern Med*. Mar 23 2009; 169(6): 551-61. PMID 19307517
21. Palmer SC, McGregor DO, Craig JC, et al. Vitamin D compounds for people with chronic kidney disease requiring dialysis. *Cochrane Database Syst Rev*. Oct 07 2009; (4): CD005633. PMID 19821349
22. Bischoff-Ferrari HA, Willett WC, Wong JB, et al. Fracture prevention with vitamin D supplementation: a meta-analysis of randomized controlled trials. *JAMA*. May 11 2005; 293(18): 2257-64. PMID 15886381
23. Appel LJ, Michos ED, Mitchell CM, et al. The Effects of Four Doses of Vitamin D Supplements on Falls in Older Adults : A Response-Adaptive, Randomized Clinical Trial. *Ann Intern Med*. Feb 2021; 174(2): 145-156. PMID 33284677
24. Sanders KM, Stuart AL, Williamson EJ, et al. Annual high-dose oral vitamin D and falls and fractures in older women: a randomized controlled trial. *JAMA*. May 12 2010; 303(18): 1815-22. PMID 20460620
25. Elamin MB, Abu Elnour NO, Elamin KB, et al. Vitamin D and cardiovascular outcomes: a systematic review and meta-analysis. *J Clin Endocrinol Metab*. Jul 2011; 96(7): 1931-42. PMID 21677037
26. Pittas AG, Chung M, Trikalinos T, et al. Systematic review: Vitamin D and cardiometabolic outcomes. *Ann Intern Med*. Mar 02 2010; 152(5): 307-14. PMID 20194237
27. Chung M, Balk EM, Brendel M, et al. Vitamin D and calcium: a systematic review of health outcomes. *Evid Rep Technol Assess (Full Rep)*. Aug 2009; (183): 1-420. PMID 20629479
28. Wang TJ, Pencina MJ, Booth SL, et al. Vitamin D deficiency and risk of cardiovascular disease. *Circulation*. Jan 29 2008; 117(4): 503-11. PMID 18180395
29. Su C, Jin B, Xia H, et al. Association between Vitamin D and Risk of Stroke: A PRISMA-Compliant Systematic Review and Meta-Analysis. *Eur Neurol*. 2021; 84(6): 399-408. PMID 34325429
30. Fu J, Sun J, Zhang C. Vitamin D supplementation and risk of stroke: A meta-analysis of randomized controlled trials. *Front Neurol*. 2022; 13: 970111. PMID 36062009
31. Bolland MJ, Avenell A, Baron JA, et al. Effect of calcium supplements on risk of myocardial infarction and cardiovascular events: meta-analysis. *BMJ*. Jul 29 2010; 341: c3691. PMID 20671013
32. Keum N, Lee DH, Greenwood DC, et al. Vitamin D supplementation and total cancer incidence and mortality: a meta-analysis of randomized controlled trials. *Ann Oncol*. May 01 2019; 30(5): 733-743. PMID 30796437
33. Bjelakovic G, Gluud LL, Nikolova D, et al. Vitamin D supplementation for prevention of cancer in adults. *Cochrane Database Syst Rev*. Jun 23 2014; (6): CD007469. PMID 24953955
34. Ott SM, Chesnut CH. Calcitriol treatment is not effective in postmenopausal osteoporosis. *Ann Intern Med*. Feb 15 1989; 110(4): 267-74. PMID 2913914
35. Grady D, Halloran B, Cummings S, et al. 1,25-Dihydroxyvitamin D3 and muscle strength in the elderly: a randomized controlled trial. *J Clin Endocrinol Metab*. Nov 1991; 73(5): 1111-7. PMID 1939527
36. Komulainen M, Kröger H, Tuppurainen MT, et al. Prevention of femoral and lumbar bone loss with hormone replacement therapy and vitamin D3 in early postmenopausal women: a population-based 5-year randomized trial. *J Clin Endocrinol Metab*. Feb 1999; 84(2): 546-52. PMID 10022414



37. Gallagher JC, Fowler SE, Detter JR, et al. Combination treatment with estrogen and calcitriol in the prevention of age-related bone loss. *J Clin Endocrinol Metab.* Aug 2001; 86(8): 3618-28. PMID 11502787
38. Trivedi DP, Doll R, Khaw KT. Effect of four monthly oral vitamin D3 (cholecalciferol) supplementation on fractures and mortality in men and women living in the community: randomised double blind controlled trial. *BMJ.* Mar 01 2003; 326(7387): 469. PMID 12609940
39. Wactawski-Wende J, Kotchen JM, Anderson GL, et al. Calcium plus vitamin D supplementation and the risk of colorectal cancer. *N Engl J Med.* Feb 16 2006; 354(7): 684-96. PMID 16481636
40. Daly RM, Petrass N, Bass S, et al. The skeletal benefits of calcium- and vitamin D3-fortified milk are sustained in older men after withdrawal of supplementation: an 18-mo follow-up study. *Am J Clin Nutr.* Mar 2008; 87(3): 771-7. PMID 18326617
41. LaCroix AZ, Kotchen J, Anderson G, et al. Calcium plus vitamin D supplementation and mortality in postmenopausal women: the Women's Health Initiative calcium-vitamin D randomized controlled trial. *J Gerontol A Biol Sci Med Sci.* May 2009; 64(5): 559-67. PMID 19221190
42. Bolton-Smith C, McMurdo ME, Paterson CR, et al. Two-year randomized controlled trial of vitamin K1 (phylloquinone) and vitamin D3 plus calcium on the bone health of older women. *J Bone Miner Res.* Apr 2007; 22(4): 509-19. PMID 17243866
43. Lappe JM, Travers-Gustafson D, Davies KM, et al. Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial. *Am J Clin Nutr.* Jun 2007; 85(6): 1586-91. PMID 17556697
44. Prince RL, Austin N, Devine A, et al. Effects of ergocalciferol added to calcium on the risk of falls in elderly high-risk women. *Arch Intern Med.* Jan 14 2008; 168(1): 103-8. PMID 18195202
45. Janssen HC, Samson MM, Verhaar HJ. Muscle strength and mobility in vitamin D-insufficient female geriatric patients: a randomized controlled trial on vitamin D and calcium supplementation. *Aging Clin Exp Res.* Feb 2010; 22(1): 78-84. PMID 20305368
46. Brunner RL, Wactawski-Wende J, Caan BJ, et al. The effect of calcium plus vitamin D on risk for invasive cancer: results of the Women's Health Initiative (WHI) calcium plus vitamin D randomized clinical trial. *Nutr Cancer.* 2011; 63(6): 827-41. PMID 21774589
47. Avenell A, MacLennan GS, Jenkinson DJ, et al. Long-term follow-up for mortality and cancer in a randomized placebo-controlled trial of vitamin D(3) and/or calcium (RECORD trial). *J Clin Endocrinol Metab.* Feb 2012; 97(2): 614-22. PMID 22112804
48. Glendenning P, Zhu K, Inderjeeth C, et al. Effects of three-monthly oral 150,000 IU cholecalciferol supplementation on falls, mobility, and muscle strength in older postmenopausal women: a randomized controlled trial. *J Bone Miner Res.* Jan 2012; 27(1): 170-6. PMID 21956713
49. Larsen T, Mose FH, Bech JN, et al. Effect of cholecalciferol supplementation during winter months in patients with hypertension: a randomized, placebo-controlled trial. *Am J Hypertens.* Nov 2012; 25(11): 1215-22. PMID 22854639
50. Murdoch DR, Slow S, Chambers ST, et al. Effect of vitamin D3 supplementation on upper respiratory tract infections in healthy adults: the VIDARIS randomized controlled trial. *JAMA.* Oct 03 2012; 308(13): 1333-9. PMID 23032549
51. Wood AD, Secombes KR, Thies F, et al. Vitamin D3 supplementation has no effect on conventional cardiovascular risk factors: a parallel-group, double-blind, placebo-controlled RCT. *J Clin Endocrinol Metab.* Oct 2012; 97(10): 3557-68. PMID 22865902
52. Witham MD, Price RJ, Struthers AD, et al. Cholecalciferol treatment to reduce blood pressure in older patients with isolated systolic hypertension: the VitDISH randomized controlled trial. *JAMA Intern Med.* Oct 14 2013; 173(18): 1672-9. PMID 23939263
53. Baron JA, Barry EL, Mott LA, et al. A Trial of Calcium and Vitamin D for the Prevention of Colorectal Adenomas. *N Engl J Med.* Oct 15 2015; 373(16): 1519-30. PMID 26465985
54. Jorde R, Sollid ST, Svartberg J, et al. Vitamin D 20,000 IU per Week for Five Years Does Not Prevent Progression From Prediabetes to Diabetes. *J Clin Endocrinol Metab.* Apr 2016; 101(4): 1647-55. PMID 26829443
55. Lappe J, Watson P, Travers-Gustafson D, et al. Effect of Vitamin D and Calcium Supplementation on Cancer Incidence in Older Women: A Randomized Clinical Trial. *JAMA.* Mar 28 2017; 317(12): 1234-1243. PMID 28350929



56. Scragg R, Khaw KT, Toop L, et al. Monthly High-Dose Vitamin D Supplementation and Cancer Risk: A Post Hoc Analysis of the Vitamin D Assessment Randomized Clinical Trial. *JAMA Oncol.* Nov 01 2018; 4(11): e182178. PMID 30027269
57. Manson JE, Cook NR, Lee IM, et al. Vitamin D Supplements and Prevention of Cancer and Cardiovascular Disease. *N Engl J Med.* Jan 03 2019; 380(1): 33-44. PMID 30415629
58. Liu M, Wang J, Sun X. A Meta-Analysis on Vitamin D Supplementation and Asthma Treatment. *Front Nutr.* 2022; 9: 860628. PMID 35873428
59. Jolliffe DA, Greenberg L, Hooper RL, et al. Vitamin D supplementation to prevent asthma exacerbations: a systematic review and meta-analysis of individual participant data. *Lancet Respir Med.* Nov 2017; 5(11): 881-890. PMID 28986128
60. Williamson A, Martineau AR, Sheikh A, et al. Vitamin D for the management of asthma. *Cochrane Database Syst Rev.* Feb 06 2023; 2(2): CD011511. PMID 36744416
61. Martineau AR, Cates CJ, Urashima M, et al. Vitamin D for the management of asthma. *Cochrane Database Syst Rev.* Sep 05 2016; 9(9): CD011511. PMID 27595415
62. Luo J, Liu D, Liu CT. Can Vitamin D Supplementation in Addition to Asthma Controllers Improve Clinical Outcomes in Patients With Asthma?: A Meta-Analysis. *Medicine (Baltimore).* Dec 2015; 94(50): e2185. PMID 26683927
63. Ramos-Martínez E, López-Vancell MR, Fernández de Córdova-Aguirre JC, et al. Reduction of respiratory infections in asthma patients supplemented with vitamin D is related to increased serum IL-10 and IFN γ levels and cathelicidin expression. *Cytokine.* Aug 2018; 108: 239-246. PMID 29402723
64. Jiang C, Yi R, Na H, Lin S. A randomized controlled study of Vitamin D3 supplementation on childhood asthma control. *Chongqing Medicine.* 2017;46(32):4505-7.
65. Jerzynska J, Stelmach W, Rychlik B, et al. The clinical effect of vitamin D supplementation combined with grass-specific sublingual immunotherapy in children with allergic rhinitis. *Allergy Asthma Proc.* 2016; 37(2): 105-14. PMID 26932169
66. Forno E, Bacharier LB, Phipatanakul W, et al. Effect of Vitamin D3 Supplementation on Severe Asthma Exacerbations in Children With Asthma and Low Vitamin D Levels: The VDKA Randomized Clinical Trial. *JAMA.* Aug 25 2020; 324(8): 752-760. PMID 32840597
67. Ducharme FM, Jensen M, Mailhot G, et al. Impact of two oral doses of 100,000 IU of vitamin D 3 in preschoolers with viral-induced asthma: a pilot randomised controlled trial. *Trials.* Feb 18 2019; 20(1): 138. PMID 30777118
68. Camargo CA, Toop L, Sluyter J, et al. Effect of Monthly Vitamin D Supplementation on Preventing Exacerbations of Asthma or Chronic Obstructive Pulmonary Disease in Older Adults: Post Hoc Analysis of a Randomized Controlled Trial. *Nutrients.* Feb 06 2021; 13(2). PMID 33561963
69. Andújar-Espinosa R, Salinero-González L, Illán-Gómez F, et al. Effect of vitamin D supplementation on asthma control in patients with vitamin D deficiency: the ACVID randomised clinical trial. *Thorax.* Feb 2021; 76(2): 126-133. PMID 33154023
70. Aglipay M, Birken C, Dai D, et al. High Dose Vitamin D for the Prevention of Wheezing in Preschoolers: A Secondary Analysis of a Randomized Clinical Trial. *J Paediatr Child Health.* 2019;24(S2):e27-e28.
71. Worth H, Stammen D, Keck E. Therapy of steroid-induced bone loss in adult asthmatics with calcium, vitamin D, and a diphosphonate. *Am J Respir Crit Care Med.* Aug 1994; 150(2): 394-7. PMID 8049820
72. Majak P, Rychlik B, Stelmach I. The effect of oral steroids with and without vitamin D3 on early efficacy of immunotherapy in asthmatic children. *Clin Exp Allergy.* Dec 2009; 39(12): 1830-41. PMID 19817753
73. Urashima M, Segawa T, Okazaki M, et al. Randomized trial of vitamin D supplementation to prevent seasonal influenza A in schoolchildren. *Am J Clin Nutr.* May 2010; 91(5): 1255-60. PMID 20219962
74. Majak P, Olszowiec-Chlebna M, Smejda K, et al. Vitamin D supplementation in children may prevent asthma exacerbation triggered by acute respiratory infection. *J Allergy Clin Immunol.* May 2011; 127(5): 1294-6. PMID 21315433
75. Lewis E, Fernandez C, Nella A, et al. Relationship of 25-hydroxyvitamin D and asthma control in children. *Ann Allergy Asthma Immunol.* Apr 2012; 108(4): 281-2. PMID 22469451



76. Baris S, Kiykim A, Ozen A, et al. Vitamin D as an adjunct to subcutaneous allergen immunotherapy in asthmatic children sensitized to house dust mite. *Allergy*. Feb 2014; 69(2): 246-53. PMID 24180595
77. Castro M, King TS, Kunselman SJ, et al. Effect of vitamin D3 on asthma treatment failures in adults with symptomatic asthma and lower vitamin D levels: the VIDA randomized clinical trial. *JAMA*. May 2014; 311(20): 2083-91. PMID 24838406
78. Yadav M, Mittal K. Effect of vitamin D supplementation on moderate to severe bronchial asthma. *Indian J Pediatr*. Jul 2014; 81(7): 650-4. PMID 24193954
79. de Groot JC, van Roon EN, Storm H, et al. Vitamin D reduces eosinophilic airway inflammation in nonatopic asthma. *J Allergy Clin Immunol*. Mar 2015; 135(3): 670-5.e3. PMID 25617224
80. Martineau AR, MacLaughlin BD, Hooper RL, et al. Double-blind randomised placebo-controlled trial of bolus-dose vitamin D3 supplementation in adults with asthma (ViDiAs). *Thorax*. May 2015; 70(5): 451-7. PMID 25724847
81. Tachimoto H, Mezawa H, Segawa T, et al. Improved control of childhood asthma with low-dose, short-term vitamin D supplementation: a randomized, double-blind, placebo-controlled trial. *Allergy*. Jul 2016; 71(7): 1001-9. PMID 26841365
82. Jensen ME, Mailhot G, Alos N, et al. Vitamin D intervention in preschoolers with viral-induced asthma (DIVA): a pilot randomised controlled trial. *Trials*. Jul 26 2016; 17(1): 353. PMID 27456232
83. Kerley CP, Hutchinson K, Cormican L, et al. Vitamin D3 for uncontrolled childhood asthma: A pilot study. *Pediatr Allergy Immunol*. Jun 2016; 27(4): 404-12. PMID 26845753
84. Musharraf MU, Sandhu GA, Mumtaz MU, Rashid MF. Role of vitamin D in prevention of acute exacerbation of bronchial asthma in adults. *J Postgrad Med Inst*. 2017;31:3103. doi: 10.1002/rmv.1909
85. Dodamani MH, Muthu V, Thakur R, et al. A randomised trial of vitamin D in acute-stage allergic bronchopulmonary aspergillosis complicating asthma. *Mycoses*. Apr 2019; 62(4): 320-327. PMID 30561849
86. Shabana MA, Esawy MM, Ismail NA, et al. Predictive role of IL-17A/IL-10 ratio in persistent asthmatic patients on vitamin D supplement. *Immunobiology*. Nov 2019; 224(6): 721-727. PMID 31570180
87. Jat KR, Goel N, Gupta N, et al. Efficacy of vitamin D supplementation in asthmatic children with vitamin D deficiency: A randomized controlled trial (ESDAC trial). *Pediatr Allergy Immunol*. Apr 2021; 32(3): 479-488. PMID 33207014
88. Thakur C, Kumar J, Kumar P, et al. Vitamin-D supplementation as an adjunct to standard treatment of asthma in children: A randomized controlled trial (ViDASTA Trial). *Pediatr Pulmonol*. Jun 2021; 56(6): 1427-1433. PMID 33522698
89. Litonjua AA, Carey VJ, Laranjo N, et al. Effect of Prenatal Supplementation With Vitamin D on Asthma or Recurrent Wheezing in Offspring by Age 3 Years: The VDAART Randomized Clinical Trial. *JAMA*. Jan 26 2016; 315(4): 362-70. PMID 26813209
90. Palacios C, Kostiuk LK, Peña-Rosas JP. Vitamin D supplementation for women during pregnancy. *Cochrane Database Syst Rev*. Jul 26 2019; 7(7): CD008873. PMID 31348529
91. Brooke OG, Brown IR, Bone CD, et al. Vitamin D supplements in pregnant Asian women: effects on calcium status and fetal growth. *British Medical Journal* 1980;1:751-754.
92. Delvin EE, Salle BL, Glorieux FH, et al. Vitamin D supplementation during pregnancy: effect on neonatal calcium homeostasis. *J Pediatr*. Aug 1986; 109(2): 328-34. PMID 3488384
93. Mallet E, Gügi B, Brunelle P, et al. Vitamin D supplementation in pregnancy: a controlled trial of two methods. *Obstet Gynecol*. Sep 1986; 68(3): 300-4. PMID 3755517
94. Marya RK, Rathee S, Dua V, et al. Effect of vitamin D supplementation during pregnancy on foetal growth. *Indian J Med Res*. Dec 1988; 88: 488-92. PMID 3243609
95. Kaur J, Marya RK, Rathee S, Lal H, Singh GP. Effect of pharmacological doses of vitamin D during pregnancy on placental protein status and birth weight. *Nutrition Research*. 1991;11(9):1077-1081.
96. Yu C, Newton L, Robinson S, Teoh TG, Sethi M. Vitamin D deficiency and supplementation in pregnant women of four ethnic groups. *Archives of Disease in Childhood. Fetal and Neonatal Edition*. 2008;93(Suppl 1):Fa68.



97. Roth DE, Al Mahmud A, Raqib R, et al. Randomized placebo-controlled trial of high-dose prenatal third-trimester vitamin D3 supplementation in Bangladesh: the AViDD trial. *Nutr J.* Apr 12 2013; 12: 47. PMID 23587190
98. Sabet Z, Ghazi AA, Tohidi M, Oladi B. Vitamin D supplementation in pregnant Iranian women: Effects on maternal and neonatal vitamin D and parathyroid hormone status. *Acta Endocrinologica.* 2012;8(1):59-66.
99. Asemi Z, Samimi M, Tabassi Z, et al. Vitamin D supplementation affects serum high-sensitivity C-reactive protein, insulin resistance, and biomarkers of oxidative stress in pregnant women. *J Nutr.* Sep 2013; 143(9): 1432-8. PMID 23884390
100. Grant CC, Stewart AW, Scragg R, et al. Vitamin D during pregnancy and infancy and infant serum 25-hydroxyvitamin D concentration. *Pediatrics.* Jan 2014; 133(1): e143-53. PMID 24344104
101. Tehrani HG, Mostajeran F, Banihashemi B. Effect of Vitamin D Supplementation on the Incidence of Gestational Diabetes. *Adv Biomed Res.* 2017; 6: 79. PMID 28808645
102. Mirghafourvand M, Mohammad-Alizadeh-Charandabi S, Mansouri A, Najafi M, Khodabande F. The effect of vitamin D and calcium plus vitamin D on sleep quality in pregnant women with leg cramps: A controlled randomized clinical trial. *Journal of Isfahan Medical School.* 2015;32(320):2444-2453.
103. Rodda CP, Benson JE, Vincent AJ, et al. Maternal vitamin D supplementation during pregnancy prevents vitamin D deficiency in the newborn: an open-label randomized controlled trial. *Clin Endocrinol (Oxf).* Sep 2015; 83(3): 363-8. PMID 25727810
104. Sablok A, Batra A, Thariani K, et al. Supplementation of vitamin D in pregnancy and its correlation with fetomaternal outcome. *Clin Endocrinol (Oxf).* Oct 2015; 83(4): 536-41. PMID 25683660
105. Singh J, Hariharan C, Bhaumik D. Role of vitamin D in reducing the risk of preterm labour. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology.* 2015;1:86-93.
106. Khan F. A randomized controlled trial of oral vitamin D supplementation in pregnancy to improve maternal periodontal health and birth weight. *Journal of International Oral Health* 2016;8(6):657-65.
107. Cooper C, Harvey NC, Bishop NJ, et al. Maternal gestational vitamin D supplementation and offspring bone health (MAVIDOS): a multicentre, double-blind, randomised placebo-controlled trial. *Lancet Diabetes Endocrinol.* May 2016; 4(5): 393-402. PMID 26944421
108. Naghshineh E, Sheikhalian S. Effect of vitamin D supplementation in the reduce risk of preeclampsia in nulliparous women. *Adv Biomed Res.* 2016; 5: 7. PMID 26962509
109. Shahgheibi S, Farhadifar F, Pouya B. The effect of vitamin D supplementation on gestational diabetes in high-risk women: Results from a randomized placebo-controlled trial. *J Res Med Sci.* 2016; 21: 2. PMID 27904548
110. Vaziri F, Dabbaghmanesh MH, Samsami A, et al. Vitamin D supplementation during pregnancy on infant anthropometric measurements and bone mass of mother-infant pairs: A randomized placebo clinical trial. *Early Hum Dev.* Dec 2016; 103: 61-68. PMID 27513714
111. Behjat Sasan S, Zandvakili F, Soufizadeh N, et al. The Effects of Vitamin D Supplement on Prevention of Recurrence of Preeclampsia in Pregnant Women with a History of Preeclampsia. *Obstet Gynecol Int.* 2017; 2017: 8249264. PMID 28912817
112. Samimi M, Kashi M, Foroozanfard F, et al. The effects of vitamin D plus calcium supplementation on metabolic profiles, biomarkers of inflammation, oxidative stress and pregnancy outcomes in pregnant women at risk for pre-eclampsia. *J Hum Nutr Diet.* Aug 2016; 29(4): 505-15. PMID 26467311
113. Pozuelo-Moyano B, Benito-León J, Mitchell AJ, et al. A systematic review of randomized, double-blind, placebo-controlled trials examining the clinical efficacy of vitamin D in multiple sclerosis. *Neuroepidemiology.* 2013; 40(3): 147-53. PMID 23257784
114. James E, Dobson R, Kuhle J, et al. The effect of vitamin D-related interventions on multiple sclerosis relapses: a meta-analysis. *Mult Scler.* Oct 2013; 19(12): 1571-9. PMID 23698130
115. Jagannath VA, Fedorowicz Z, Asokan GV, et al. Vitamin D for the management of multiple sclerosis. *Cochrane Database Syst Rev.* Dec 08 2010; (12): CD008422. PMID 21154396
116. LeBlanc ES, Chou R, Pappas M. Screening for vitamin D deficiency. *Ann Intern Med.* May 19 2015; 162(10): 738. PMID 25984861



117. Newberry SJ, Chung M, Shekelle PG, et al. Vitamin D and Calcium: A Systematic Review of Health Outcomes (Update). Evidence Report/Technology Assessment No. 217. Rockville, MD: Agency for Healthcare Research and Quality; 2014.
118. Chowdhury R, Kunutsor S, Vitezova A, et al. Vitamin D and risk of cause specific death: systematic review and meta-analysis of observational cohort and randomised intervention studies. *BMJ*. Apr 01 2014; 348: g1903. PMID 24690623
119. Bjelakovic G, Gluud LL, Nikolova D, et al. Vitamin D supplementation for prevention of mortality in adults. *Cochrane Database Syst Rev*. Jan 10 2014; (1): CD007470. PMID 24414552
120. Palmer SC, McGregor DO, Craig JC, et al. Vitamin D compounds for people with chronic kidney disease not requiring dialysis. *Cochrane Database Syst Rev*. Oct 07 2009; (4): CD008175. PMID 19821446
121. ACOG Committee Opinion No. 495: Vitamin D: Screening and supplementation during pregnancy. *Obstet Gynecol*. Jul 2011; 118(1): 197-198. PMID 21691184
122. Holick MF, Binkley NC, Bischoff-Ferrari HA, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. Jul 2011; 96(7): 1911-30. PMID 21646368
123. Krist AH, Davidson KW, Mangione CM, et al. Screening for Vitamin D Deficiency in Adults: US Preventive Services Task Force Recommendation Statement. *JAMA*. Apr 13 2021; 325(14): 1436-1442. PMID 33847711
124. Kahwati LC, LeBlanc E, Weber RP, et al. Screening for Vitamin D Deficiency in Adults: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA*. Apr 13 2021; 325(14): 1443-1463. PMID 33847712
125. Noridian Healthcare Solutions. Local Coverage Determination (LCD): Vitamin D Assay Testing (L36692). 2017; <https://med.noridianmedicare.com/documents/10546/6990981/Vitamin+D+Assay+Testing+LCD>. Accessed January 9, 2024.

History

Date	Comments
6/12/12	New policy, add to Pathology/Laboratory section. Approved with 90-day hold for provider notification; the effective date is November 12, 2012. Policy not applicable to Oregon at this time.
02/11/13	Policy became effective in Oregon.
06/10/13	Replace policy. Indications put in alphabetical order. Literature review through April 2013 resulted in addition of practice guidelines from the National Osteoporosis Foundation and USPSTF. Reference 6-7 added, others renumbered. Policy statement unchanged. Benefit Application updated with recommendations from the USPSTF and language supporting federal preventative care mandates on coverage of vitamin D supplementation for those aged 65 years and older. A single policy will now be maintained; the Oregon version will no longer be maintained, as it was the same policy with only a different effective date (2/11/13) following approval 6/12/12 and a hold for provider notification.
06/13/14	Annual Review. No change in policy statements.
08/13/14	Coding update: duplicate codes removed from ICD-9 diagnosis section; codes incorrectly listed corrected; 27549 and 275.40 added.



Date	Comments
02/25/15	Annual Review. Policy updated with a literature review through January, 2015. References 9-12 added; others renumbered. Policy statements unchanged.
04/13/15	Coding update. ICD-9 diagnosis code descriptors updated.
07/14/15	Interim Review. Added rationale and reference 3 and renumbered others. Updated diagnosis codes, removing several and adding ICD-10 diagnosis codes.
01/12/16	Delete policy, replaced with 2.04.135 (BC version).
02/04/16	Coding update. Added ICD10 diagnosis code E74.21.
02/19/16	Coding update. Minor clarifications to osteomalacia code range and correction to code K70.0.
08/01/16	Interim Update, approved July 12, 2016. Policy published in new template with introduction added. Clarified institutional information. Intent remains the same.
03/01/17	Annual review, approved February 14, 2017. Policy updated literature review through October 10, 2016; references 14-16, 29, 31-36, 43, and 45 added. Policy statements unchanged.
08/15/17	Minor formatting updates.
03/01/18	Annual Review, approved February 6, 2018. Policy updated with literature review through October 2017; references 32-34 and 36-48 added; notes 15 and 62 updated. Policy statements unchanged.
10/01/18	Coding update. Updated diagnosis code range for "other diseases of biliary tract" from K83.0 – 8.39 to K83.1 – K83.9.
12/01/18	Interim Review, approved November 6, 2018. Clarified policy statements regarding repeat testing. Added diagnosis code range L92.0 – L92.9.
02/01/19	Annual Review, approved January 22, 2019. Policy updated, literature review through October 2018; reference 58 added; reference 57, 59, and 61 updated. Policy statements unchanged. Coding update, added diagnosis ranges A15.0, B38.0-B38.9, B39.0-B39.9, E84.0-E84.9, E85.0-E85.9, J63.2, K50.00-K50.919, K51.00-K51.919, K52.0, K86.0-K86.9, and Z98.84. Added code 0038U.
03/01/20	Annual Review, approved February 4, 2020. Policy updated literature review through October 2019; references on Guidelines updated. Policy statements unchanged.
03/01/21	Annual Review, approved February 2, 2021. Policy updated literature review through October 14, 2019; references on Guidelines updated. Policy statements unchanged.
03/01/22	Annual Review, approved February 7, 2022. Policy updated with literature review through October 20, 2021; references added. Policy statements unchanged.
03/01/23	Policy renumbered, approved February 14, 2023 from 2.04.135 to 2.04.507 Testing Serum Vitamin D Levels. Policy statements unchanged. Policy updated with literature review through October 24, 2022; references added. Changed the wording from "patient" to "individual" throughout the policy for standardization.



Date	Comments
05/01/23	Coding update. Added ICD-10-CM codes A28.1, B20, B41.0, B41.7, B41.9, B59, E05.00-E05.91, M88.0, M88.1, M88.811, M88.812, M88.821, M88.822, M88.831, M88.832, M88.841, M88.842, M88.851, M88.852, M88.861, M88.862, M88.871, M88.88, M88.89, M88.9, Z79.51, Z94.0-Z94.9, Z98.0 to coding table.
03/01/24	Annual Review, approved February 12, 2024. Policy updated with literature review through October 16, 2023; references added. Policy statements unchanged.

Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. The Company adopts policies after careful review of published peer-reviewed scientific literature, national guidelines and local standards of practice. Since medical technology is constantly changing, the Company reserves the right to review and update policies as appropriate. Member contracts differ in their benefits. Always consult the member benefit booklet or contact a member service representative to determine coverage for a specific medical service or supply. CPT codes, descriptions and materials are copyrighted by the American Medical Association (AMA). ©2024 Premera All Rights Reserved.

Scope: Medical policies are systematically developed guidelines that serve as a resource for Company staff when determining coverage for specific medical procedures, drugs or devices. Coverage for medical services is subject to the limits and conditions of the member benefit plan. Members and their providers should consult the member benefit booklet or contact a customer service representative to determine whether there are any benefit limitations applicable to this service or supply. This medical policy does not apply to Medicare Advantage.





Discrimination is Against the Law

LifeWise Health Plan of Washington (LifeWise) complies with applicable Federal and Washington state civil rights laws and does not discriminate on the basis of race, color, national origin, age, disability, sex, gender identity, or sexual orientation. LifeWise does not exclude people or treat them differently because of race, color, national origin, age, disability, sex, gender identity, or sexual orientation. LifeWise provides free aids and services to people with disabilities to communicate effectively with us, such as qualified sign language interpreters and written information in other formats (large print, audio, accessible electronic formats, other formats). LifeWise provides free language services to people whose primary language is not English, such as qualified interpreters and information written in other languages. If you need these services, contact the Civil Rights Coordinator. If you believe that LifeWise has failed to provide these services or discriminated in another way on the basis of race, color, national origin, age, disability, sex, gender identity, or sexual orientation, you can file a grievance with: Civil Rights Coordinator — Complaints and Appeals, PO Box 91102, Seattle, WA 98111, Toll free: 855-332-6396, Fax: 425-918-5592, TTY: 711, Email AppealsDepartmentInquiries@LifeWiseHealth.com. You can file a grievance in person or by mail, fax, or email. If you need help filing a grievance, the Civil Rights Coordinator is available to help you. You can also file a civil rights complaint with the U.S. Department of Health and Human Services, Office for Civil Rights, electronically through the Office for Civil Rights Complaint Portal, available at <https://ocrportal.hhs.gov/ocr/portal/lobby.jsf>, or by mail or phone at: U.S. Department of Health and Human Services, 200 Independence Ave SW, Room 509F, HHH Building, Washington, D.C. 20201, 1-800-368-1019, 800-537-7697 (TDD). Complaint forms are available at <http://www.hhs.gov/ocr/office/file/index.html>. You can also file a civil rights complaint with the Washington State Office of the Insurance Commissioner, electronically through the Office of the Insurance Commissioner Complaint Portal available at <https://www.insurance.wa.gov/file-complaint-or-check-your-complaint-status>, or by phone at 800-562-6900, 360-586-0241 (TDD). Complaint forms are available at <https://fortress.wa.gov/oic/onlineservices/cc/pub/complaintinformation.aspx>.

Language Assistance

ATENCIÓN: si habla español, tiene a su disposición servicios gratuitos de asistencia lingüística. Llame al 800-817-3056 (TTY: 711).

注意: 如果您使用繁體中文，您可以免費獲得語言援助服務。請致電 800-817-3056 (TTY: 711)。

CHÚ Ý: Nếu bạn nói Tiếng Việt, có các dịch vụ hỗ trợ ngôn ngữ miễn phí dành cho bạn. Gọi số 800-817-3056 (TTY: 711).

주의: 한국어를 사용하시는 경우, 언어 지원 서비스를 무료로 이용하실 수 있습니다. 800-817-3056 (TTY: 711) 번으로 전화해 주십시오.

ВНИМАНИЕ: Если вы говорите на русском языке, то вам доступны бесплатные услуги перевода. Звоните 800-817-3056 (телетайп: 711).

PAUNAWA: Kung nagsasalita ka ng Tagalog, maaari kang gumamit ng mga serbisyo ng tulong sa wika nang walang bayad. Tumawag sa 800-817-3056 (TTY: 711).

УВАГА! Якщо ви розмовляєте українською мовою, ви можете звернутися до безкоштовної служби мовної підтримки.

Телефонуйте за номером 800-817-3056 (телетайп: 711).

ប្រយ័ត្ន: បើសិនជាអ្នកនិយាយ ភាសាខ្មែរ, សេវាជំនួយផ្នែកភាសា ដោយមិនគិតលុយ គឺអាចមានសំរាប់អ្នក។ ចូរ ទូរស័ព្ទ 800-817-3056 (TTY: 711)។

注意事項: 日本語を話される場合、無料の言語支援をご利用いただけます。800-817-3056 (TTY:711) まで、お電話にてご連絡ください。

ማስታወሻ: የሚናገሩት ቋንቋ አማርኛ ከሆነ የትርጉም እርዳታ ድርጅቶች፣ በገጻ ሊያገለግሉት ተዘጋጅተዋል። ወደ ሚከተለው ቁጥር ይደውሉ 800-817-3056 (መስማት ለተሳናቸው: 711)።

XIYYEEFFANNAA: Afaan dubbattu Oroomiffa, tajaajjila gargaarsa afaanii, kanfaltiidhaan ala, ni argama. Bilbilaa 800-817-3056 (TTY: 711).

ملحوظة: إذا كنت تتحدث اذكر اللغة، فإن خدمات المساعدة اللغوية تتوافر لك بالمجان. اتصل برقم 800-817-3056 (رقم هاتف الصم والبكم: 711).

ਧਿਆਨ ਦਿਓ: ਜੇ ਤੁਸੀਂ ਪੰਜਾਬੀ ਬੋਲਦੇ ਹੋ, ਤਾਂ ਭਾਸ਼ਾ ਵਿੱਚ ਸਹਾਇਤਾ ਸੇਵਾ ਤੁਹਾਡੇ ਲਈ ਮੁਫਤ ਉਪਲਬਧ ਹੈ। 800-817-3056 (TTY: 711) 'ਤੇ ਕਾਲ ਕਰੋ।

ACHTUNG: Wenn Sie Deutsch sprechen, stehen Ihnen kostenlos sprachliche Hilfsdienstleistungen zur Verfügung. Rufnummer: 800-817-3056 (TTY: 711).

ໂປດອຸບ: ຖ້າວ່າ ທ່ານເວົ້າພາສາ ລາວ, ການບໍລິການຊ່ວຍເຫຼືອດ້ານພາສາ, ໂດຍບໍ່ຄ່າສ່ຽງຄ່າ, ຄວນມີພ້ອມໃຫ້ທ່ານ. ໂທ 800-817-3056 (TTY: 711).

ATANSYON: Si w pale Kreyòl Ayisyen, gen sévis èd pou lang ki disponib gratis pou ou. Rele 800-817-3056 (TTY: 711).

ATTENTION: Si vous parlez français, des services d'aide linguistique vous sont proposés gratuitement. Appelez le 800-817-3056 (ATS : 711).

UWAGA: Jezeli mówisz po polsku, możesz skorzystać z bezpłatnej pomocy językowej. Zadzwoń pod numer 800-817-3056 (TTY: 711).

ATENÇÃO: Se fala português, encontram-se disponíveis serviços linguísticos, grátis. Ligue para 800-817-3056 (TTY: 711).

ATTENZIONE: In caso la lingua parlata sia l'italiano, sono disponibili servizi di assistenza linguistica gratuiti. Chiamare il numero 800-817-3056 (TTY: 711).

توجہ: اگر بہ زبان فارسی گفتگو می کنید، تسهیلات زبانی بصورت رایگان برای شما فراهم می باشد. با 800-817-3056 (TTY: 711) تماس بگیرید.