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Review

Rational Use of Vitamin D Testing: Evidence, Indications, and Health System Implications: A Narrative Review

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ABSTRACT

Background: Vitamin D is required for calcium and phosphate homeostasis. Severe deficiency causes rickets in children and osteomalacia in adults .Objective: Requests for serum vitamin D tests have increased sharply in many health systems, although guidelines do not support screening adults without symptoms or risk factors. This review examines when measuring 25-hydroxyvitamin D changes patient management and how unnecessary testing can be reduced, with attention to Iraq and the Middle East.

Methods: A narrative review of guidelines, randomized trials, systematic reviews, studies of test utilization and de-implementation, identified through PubMed and guideline and journal websites (last search 13 October 2026) and summarized qualitatively.

Results: No guideline recommends screening the general adult population, and current guidance supports supplementing groups such as adults aged 75 years or older and pregnant women without prior testing. Testing remains useful when osteomalacia, malabsorption, chronic kidney disease, or a mineral disorder is suspected. Large trials in unselected adults showed no reduction in cancer, cardiovascular events, fractures, or death, and a test-and-treat trial did not prevent respiratory infection. Differences in thresholds, assays, season, and acute illness complicate interpretation. Electronic alerts, requisition forms, and coverage rules reduced testing by 8% to 91%, but rarely measured patient outcomes. Iraqi data come from laboratory-referred samples and cannot show how often testing is inappropriate.

Conclusions: Vitamin D should be measured to answer a defined clinical question. Iraqi services should audit indications and repeat testing, agree on local criteria, and monitor missed deficiency.

Introduction

Vitamin D is required for calcium and phosphate homeostasis. Severe deficiency causes rickets in children and osteomalacia in adults [1]. Measuring its level is therefore justified when these disorders or abnormal mineral results are suspected. Measuring it in people without symptoms is a different matter: the US Preventive Services Task Force (USPSTF) found insufficient evidence to judge the benefits and harms of screening asymptomatic adults [2] [3].

The usual laboratory measure is total serum 25-hydroxyvitamin D [25(OH)D], which includes the metabolites of both vitamin D2 and vitamin D3. For this reason, this review is concerned with vitamin D testing rather than vitamin D3 testing. A test is clinically useful when its result helps to make a diagnosis or changes treatment, and placing a value inside or outside a laboratory range is only part of that judgment [4].

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Observational studies link low 25(OH)D with many adverse outcomes, but confounding and the effect of illness on vitamin D status make causal conclusions unreliable [5]. At the same time, testing volumes and costs have grown in several countries [6].

Guidelines agree that the general adult population should not be screened, yet they differ on risk groups and thresholds [7]. This review asks when ordering a 25(OH)D test leads to a better decision for the patient. It covers measurement, indications, trial evidence, testing patterns, harms of overuse, and interventions for its reduction, and then considers what applies to Iraq and the Middle East.

Methods

This is a narrative (non-systematic) review. The search covered PubMed; the websites of professional and public health organizations, including the USPSTF, the Endocrine Society, the National Institute for Health and Care Excellence, Choosing Wisely Canada, the Royal Osteoporosis Society, the Royal College of Pathologists of Australasia, Kidney Disease: Improving Global Outcomes, and the World Health Organization Regional Office for the Eastern Mediterranean; and the websites of journals that published the retrieved articles. The last search was run on 13 October 2026.

Search terms combined "vitamin D" or "25-hydroxyvitamin D" with "screening", "overuse", "repeated testing", "de-implementation", "clinical decision support", and "Middle East". The main search had no start date. A second, targeted search for publications from 2024 to 2026 was added so that recent studies of repeat testing, the durability of restrictions, point-of-care devices, and regional guidance were not missed.

Guidelines, consensus statements, randomized controlled trials, systematic reviews, and observational or implementation studies were included when they dealt with indications for testing, interpretation of results, test utilization, or interventions to change ordering. Older publications were kept when they defined thresholds, documented early testing trends, or reported major trials. Studies that examined vitamin D only as a risk factor for a particular disease, without bearing on testing decisions, were not included. The authors selected studies without an independent second reviewer. No protocol was registered, and no formal risk-of-bias assessment or meta-analysis was performed. Reported figures were checked against full texts, abstracts, or guideline documents, and bibliographic details were checked against PubMed records.

Measurement and Interpretation

Choice of analyte

Total 25(OH)D is the standard biochemical measure of vitamin D status. The active hormone, 1,25-dihydroxycholecalciferol, is regulated by parathyroid hormone, calcium, phosphate, and kidney function, and it cannot replace 25(OH)D when nutritional deficiency is suspected [1,4]. Its measurement belongs to selected specialist investigations.

Thresholds

The cut-off values differ between organizations and purposes. The Institute of Medicine concluded that a 25(OH)D concentration of about 20 ng/mL (50 nmol/L) meets the bone health needs of most healthy people and that values below about 12 ng/mL (30 nmol/L) carry a risk of deficiency [8]. The 2011 Endocrine Society guideline defined deficiency as below 20 ng/mL and insufficiency as 21 to 29 ng/mL [9], whereas the 2024 guideline did not endorse any outcome-based threshold for generally healthy people [10]. Using the older categories without stating their source labels a large part of the population as deficient or insufficient. The threshold also drives prevalence: in standardized European data, 13.0% of people had values

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below 30 nmol/L and 40.4% below 50 nmol/L [11]. Laboratory reports should therefore state the threshold, units, and assay.

Analytical and biological variation

Assays differ, and the differences matter most near a cut-off. Liquid chromatography-tandem mass spectrometry (LC-MS/MS), which separates vitamin D metabolites before measuring them by mass, is the reference approach, but it still needs calibration and external quality assessment, and a method name alone does not guarantee agreement between laboratories [4,12]. Season also changes concentrations; in European data, more people had values below 30 nmol/L in winter than in summer [11]. Acute illness lowers circulating 25(OH)D, which behaves as a negative acute-phase reactant, so a low value on hospital admission may reflect inflammation as much as nutritional status [13]. Point-of-care devices raise a further question of accuracy. A 2026 systematic review found only four small clinical studies, with 6 to 20 samples per comparison, and could not recommend any device [14].

Indications for Testing

Screening and diagnostic testing

Screening means testing people without symptoms to find early disease. Diagnostic testing investigates a suspected problem, such as osteomalacia or an unexplained mineral abnormality, and monitoring checks whether an existing condition or treatment needs adjustment. Each purpose has to be judged on its own terms [2] [15].

The USPSTF issued an "I" statement in 2021 for screening community-dwelling, non-pregnant adults. Its evidence review found no studies of the benefits or harms of screening itself, and treatment trials showed no consistent benefit [2] [3].

The 2024 Endocrine Society guideline, which replaced the 2011 version, suggests against routine 25(OH)D testing in all the populations it covers, including healthy adults and pregnant women. It suggests empiric supplementation without testing for children, adolescents, adults aged 75 years or older, pregnant women, and adults with high-risk prediabetes [10]. A recommendation to supplement a group therefore does not mean that each member needs a test first.

The National Institute for Health and Care Excellence (NICE) and Choosing Wisely Canada advise against routine testing in low-risk adults but accept testing for symptoms, high risk, or another clinical reason [16][17]. Clinical guidance from the Royal Osteoporosis Society and the Royal College of Pathologists of Australasia supports testing for suspected bone disease, malabsorption, and mineral abnormalities [18] [19]. A 2025 systematic review of 31 clinical guidelines published in Europe and North America found that none recommended screening the general adult population, although risk groups and thresholds varied [7].

When a result may change treatment

Testing is useful when osteomalacia is suspected, when bone disease could respond to correction of deficiency, or before treatments for which vitamin D status changes the plan [15]. Osteoporosis alone does not make repeated measurement necessary, and measurement is often unnecessary when vitamin D is already prescribed with an oral antiresorptive [18]. Measurement can also guide treatment in malabsorption, after major gastrointestinal surgery, in liver cirrhosis or parathyroid disease, and with drugs that alter vitamin D metabolism, such as anticonvulsants and glucocorticoids [17]. For chronic kidney disease (CKD) stages G3a to G5D (from moderately reduced kidney function to kidney failure treated with dialysis), Kidney Disease: Improving Global Outcomes (KDIGO) suggests measuring 25(OH)D, with repeat testing guided by the baseline value and treatment [20]. Fatigue on its own is not a specific sign of deficiency. Before ordering, the clinician should know how a low, borderline, or normal

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result would change the next step; if the plan would be the same for every result, the test adds little. Table 1 summarizes these situations.

Table 1. Clinical situations and the role of vitamin D testing.

Clinical situation	Role of testing	Practical point
Healthy adult without an indication	Routine screening not recommended; evidence insufficient [2,10,17]	Dietary or supplement advice does not need a baseline test.
Suspected osteomalacia or mineral abnormality	Diagnostic testing informs assessment and treatment [15,18,19]	Interpret with symptoms, calcium and phosphate results, and other investigations as indicated.
Osteoporosis or bone-directed therapy	Measure selectively when the result changes management [15,18]	Neither the diagnosis nor ongoing treatment justifies repeated testing by itself.
Malabsorption or relevant gastrointestinal surgery	May guide treatment when absorption is uncertain [17,19]	Follow-up should answer a defined question about response or dose.
CKD stages G3a to G5D	KDIGO suggests measuring 25(OH)D [20]	Repeat testing depends on the baseline value and treatment.
Pregnancy or age 75 years or older, without another indication	Empiric supplementation without routine testing [10]	An indication to supplement is not an indication to test.
Follow-up of treated deficiency	Selective reassessment when symptoms, absorption, or adherence raise doubt [15,21]	Avoid automatic repeat testing after a single low result.

25(OH)D, 25-hydroxyvitamin D; CKD, chronic kidney disease; KDIGO, Kidney Disease: Improving Global Outcomes. The table summarizes the cited guidance and does not replace condition-specific guidelines.

Follow-up testing

A repeat test is justified when it answers a new question, such as persistent symptoms, suspected poor adherence, malabsorption, or an uncertain response to treatment. For a patient doing well on a stable dose, repeating the test only to confirm a target level is rarely needed [15][20]. Recommended intervals differ. The Royal Osteoporosis Society suggests waiting at least three months after treatment starts [18], and a 2024 international consensus suggests eight to twelve weeks when adherence or persistently low levels are a concern [21]. Neither proposes routine retesting of everyone on supplements. When 25(OH)D stays low, the clinician should review adherence, the actual product and dose, absorption, and the assay before increasing treatment. When toxicity is suspected, calcium and kidney function tell more than a second 25(OH)D value [22].

Evidence from Randomized Trials

Supplementation trials show whether giving vitamin D helps; they do not show whether testing helps. A neutral result in an unselected population also does not rule out benefit for people who are severely deficient or symptomatic [3]. Systematic reviews of non-skeletal outcomes have found little support for most of the proposed benefits [23].

The largest trials enrolled participants regardless of vitamin D status. In the VITamin D and OmegA-3 TriaL (VITAL; 25,871 participants), vitamin D3 2,000 IU daily did not reduce invasive cancer (hazard ratio [HR] 0.96, 95% confidence interval [CI] 0.88 to 1.06) or major cardiovascular events (HR 0.97, 95% CI 0.85 to 1.12) [24], and a fracture analysis found no reduction in total fractures (HR 0.98, 95% CI 0.89 to 1.08) [25]. In the Australian D-Health trial (21,315 participants), 60,000 IU monthly did not reduce all-cause mortality (HR 1.04, 95% CI 0.93 to 1.18) [26]. For major cardiovascular events the HR was 0.91 (95% CI 0.81 to 1.01); the point estimate favored vitamin D, but the interval includes no effect, so the result justifies further trials rather than screening [27]. In people with prediabetes, an individual-participant meta-analysis of three trials (4,190 participants) found a lower risk of diabetes (HR 0.85, 95%

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CI 0.75 to 0.96; absolute risk reduction 3.3% at three years) [28]. This finding supports targeted supplementation in that group, not testing everyone or aiming for a particular serum level.

Only one trial has tested a test-and-treat strategy directly. The CORONAVIT trial, a phase 3 trial of vitamin D to prevent COVID-19 and other acute respiratory infections, randomized 6,200 people aged 16 years or older in the United Kingdom either to an offer of 25(OH)D testing, followed by 800 or 3,200 IU daily for those below 75 nmol/L, or to no offer. Neither strategy reduced acute respiratory infection or COVID-19 over six months [29]. The 2025 updated meta-analysis of supplementation for respiratory infection likewise showed no statistically significant protection (odds ratio 0.94, 95% CI 0.88 to 1.00) [30]. These trials leave room for benefit in selected groups, such as people with prediabetes, but they give no support to measuring 25(OH)D in people without a clinical indication.

Patterns of Testing

Testing has risen sharply over the past two decades. In UK primary care, the incidence of first tests increased from 0.29 to 16.1 per 1,000 person-years at risk from 2005 to 2015 [31]. More recent data show the same direction: in a Spanish hospital laboratory, annual requests rose from 10,830 in 2015 to nearly 85,000 in 2023 [32]. Repeat testing is a separate problem. Among 362,618 tests from Auckland, New Zealand, 34% were repeats, 58% of repeats were done within one year, and most repeat results were not low [33]. Restrictions can also wear off. In Ontario, criteria-based funding introduced in 2010 cut publicly funded testing by 82.6%, but by 2023 the rate of 30.2 tests per 1,000 patient visits per month was close to the 2009 rate of 30.4 [34]. Most of these studies counted tests without reviewing the indication behind each request, so they show the number of tests and repeat patterns rather than the share of tests that were inappropriate.

Why Unnecessary Testing Persists

Patients may see a vitamin D test as a way to explain their symptoms and obtain treatment [35], and patients and general practitioners can disagree about when vitamin testing is appropriate [36]. Clinicians facing persistent symptoms, an earlier low result, or conflicting thresholds may order a test because it seems to offer a clear next step, even when its link to the symptom is weak [4][36]. A consultation that explains whether the result would change management or not, considers other causes of the symptoms, and plans a review may meet the patient's concern without a test, although this approach has not been evaluated in trials.

The design of laboratory ordering systems also affects how often the test is requested. When vitamin D is part of a routine panel or a one-click order list, it can be requested without a new reason, and studies that changed these defaults reduced testing [37][38].

Consequences of Low-Value Testing

Clinical consequences

A mildly low result in a person without a clear indication can lead to a diagnosis of deficiency, supplementation, and repeat testing before any clinical problem is shown, the sequence described in the wider literature on overdiagnosis [39]. How often this harms patients is not known. Vitamin D toxicity, with hypercalcemia and kidney injury, is uncommon and usually follows very high doses, prescribing errors, or poorly controlled products [22,40]. Checking the concentration per tablet or drop, separating loading from maintenance doses, and recording non-prescribed products reduce this risk [40]. Another risk is premature attribution of a nonspecific symptom to a mildly low level, which can delay the search for its real cause. Evidence on the direct harms of screening remains much thinner than evidence on test volume and cost [3].

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Economic and environmental consequences

The cost of a test includes sample collection, transport, processing, interpretation, extra visits, and later treatment, and charges, reimbursements, and laboratory costs are not the same thing. In one alert study, each alert displayed reduced charges by about 14.7 US$ but laboratory spending by only 0.34 US$ [41]. In Australia, an estimated 76.5% of the 4.46 million Medicare-funded tests in 2020 gave no net health benefit; these tests cost more than AUD 87 million and produced an estimated 28,576 to 42,012 kg of carbon dioxide equivalent [6]. These figures are modelled estimates and depend on assumptions about which tests were unnecessary.

Ethics and equity

Low-value tests cost patients money and use resources needed elsewhere, yet restrictive rules can block access to needed tests, especially when they add appointments or referrals. Any restriction should keep exceptions easy to use, explain to patients why a test is not ordered, and be monitored for unintended effects [42].

Interventions to Reduce Unnecessary Testing

Interventions should target the reason a test is ordered. Education may help when clinicians are unsure about indications but does little when the test is ordered by default, and a systematic review of interventions against low-value services found mixed results across settings [43]. Vitamin D studies follow this pattern. In UK hospitals, passive information did not reduce requests, whereas removing automatic testing in the emergency department and adding a decision tool reduced them, saving about 44 kg of carbon dioxide equivalent [38]. An electronic alert tested against a control group reduced completed orders from 98.1% to 89.9% over 80 days [41]. A combined guideline, hard-stop alert, and removal of ordering shortcuts lowered screening from 74.0 to 24.2 tests per 1,000 members and raised the share of appropriate tests from 56.2% to 69.7% [37]. A special requisition form in Alberta was followed by 29,525 tests against 342,477 predicted, a 91.4% reduction [44].

Coverage and laboratory rules produced some of the largest reductions. In Swiss claims data covering about 880,000 people, a Choosing Wisely recommendation reduced tests per physician by 5.98% over 12 months, whereas a national coverage restriction reduced them by 57.82% over six months [45]. Laboratory demand-management rules in Spain rejected 36,781 requests in about two years, saved an estimated EUR 85,600 in reagents, and reduced follow-up testing from about 15% to 5% [32]. A targeted electronic advisory in a three-hospital US system reduced tests by 25.3% and raised the share with an approved indication from 45% to above 90% at one year, although some clinicians bypassed it with unspecified diagnosis codes [46]. In the WISE-D study in two Swiss hospitals (31,755 hospitalizations), training reduced inappropriate testing by 1.3%, with no difference between brief and intensive formats, and inappropriate supplementation did not change [47].

Because these studies differ in design, setting, and outcome definition, their percentages should not be compared as if they came from one population. Most were before-and-after evaluations that measured test counts; few measured missed deficiency, patient outcomes, or total cost.

The Middle East and Iraq

Low vitamin D concentrations are common in the Middle East, in relation to diet, clothing, limited sun exposure, and health status [48]. A common deficiency does not by itself justify testing everyone, and guidance from one setting may not transfer to another. The 2018 United Arab Emirates guideline recommends supplementation by risk category with a serum target of 30 to 50 ng/mL [49]. The 2020 Gulf Cooperation Council consensus recommends standardized assays and testing only people at high risk, and it lists retesting intervals and regional cut-offs as research needs [50]. A 2024 consultation report of the World Health Organization Regional Office for the Eastern Mediterranean advised assessing sick or at-risk

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adults rather than population screening and called for representative nutrition surveys, standard protocols, and country-level implementation [51]. The report is not a finished clinical guideline for Iraq.

Iraqi data must be read according to how the samples were collected. An Erbil study of 10,823 records from private laboratories described concentrations among people already referred for testing [52]. Such data cannot estimate population prevalence or show how many tests were appropriate.

A practical first step for Iraq is an audit of public and private laboratory requests that records the indication, age group, clinical setting, previous tests, assay, treatment decision, and cost to the patient, in line with the regional call for standardized local data [51]. A sample of records should be checked against clinical notes, because an order without a diagnostic code is not necessarily inappropriate [46]. Outcomes should include changes in management, appropriate requests that were refused or delayed, out-of-pocket costs, and hypercalcemia after treatment [53]. Public information in Arabic should explain the difference between prevention and treatment and when symptoms need medical review, and it should be tested with patients and primary care doctors, since patient expectations shape requests [35].

Discussion

Across guidelines and trials, the findings are consistent. Guidelines agree that adults without symptoms or risk factors should not be screened; trials in unselected adults show no benefit of supplementation for the major outcomes studied, and the only test-and-treat trial, which examined respiratory infection only, found no benefit. Testing remains useful when the clinician has a specific question, most clearly in suspected osteomalacia, malabsorption, CKD, and mineral disorders.

Several gaps remain in the evidence. No trial has compared screening with no screening for skeletal outcomes, and the test-and-treat trial addressed only infection over six months. Most de-implementation studies counted tests and rarely reported missed deficiency, delayed diagnosis, or harm from supplements, so a large fall in volume does not prove better care. Two findings deserve attention from anyone designing a policy: testing can return to earlier levels years after a restriction [34], and clinicians may route around electronic prompts [46]. WISE-D also showed that testing and supplementation can change independently [47]. Because thresholds remain contested, the label "inappropriate" partly depends on which guideline is applied.

Future studies should measure appropriateness and patient outcomes together, including changes in management, missed deficiency, delayed alternative diagnoses, adverse effects of supplements, and fair access, and they should analyze repeat tests separately from first tests. Hybrid effectiveness-implementation designs can test indication prompts, audit and feedback, and default changes while recording what services need in order to adopt them [53] [54].

Economic studies should count laboratory test, consultation, out-of-pocket, and downstream treatment costs, and environmental estimates should state their boundaries and use local data. Studies in Iraq should also ask why patients seek testing and how clinicians respond to results, because findings from other countries may not apply.

This review has limitations. Its focused narrative design may have missed relevant studies, and it cannot give pooled estimates of inappropriate testing. Guidelines differ in scope, intervention studies use different definitions, and the regional studies relied on clinical or laboratory samples. These limits restrict causal inference and the transfer of numerical estimates to Iraq.

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In the authors' view, Iraqi practice would gain most from a short, locally agreed list of indications for 25(OH)D testing, one reporting unit with stated cut-offs, and an audit that tracks repeat tests and missed deficiency alongside test volume.

Conclusion

Vitamin D testing is useful when it forms part of the assessment or management of a defined clinical problem. Current evidence does not show that measuring 25(OH)D in people without symptoms improves outcomes, and most guidelines support selective testing. Good practice means a clear indication, interpretation in context, follow-up only when it answers a new question, and an explanation for the patient. Savings in cost and carbon support this approach but should be measured openly. In Iraq, local data on who is tested, why, and with what result are needed before policy is set, so that unnecessary tests fall without blocking access to needed ones.

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