How Much Daily Vitamin D3 Does It Take to Get >95% of People to 30, 40, and 50 ng/mL?

TL;DR

- **Getting >95–97.5% of a healthy adult population *above* a 25(OH)D threshold requires far higher daily D3 than getting the average person there.** The best-supported flat-daily *supplemental* estimates to push ~97.5% of a general adult population above each level (on top of a typical food+sun baseline) are roughly **6,200 IU/day for 30 ng/mL** and **~9,100–9,600 IU/day for 40 ng/mL**; reaching **50 ng/mL in ~97.5% of people has no validated number** and would require doses (likely well above 10,000 IU/day) that exceed conventional safety guidance and the studied dose range.
- **The "mean person" doses are dramatically lower:** modeling of healthy *normal-weight* adults (Ekwaru 2014) puts the *average*-person requirement at ~28 IU/day for 30 ng/mL (food+sun baseline alone nearly suffices), ~2,080 IU/day for 40 ng/mL, and ~4,964 IU/day for 50 ng/mL. The gap between "median person" and "97.5th-percentile person" is the entire crux of the IOM RDA controversy.
- **Obese adults need roughly 1.5× (overweight) to 2–3× (obese) more** than normal-weight adults for the same target; nearly all of these population-level numbers come from **observational cohorts (GrassrootsHealth) or regression modeling, not RCTs**, so they are directionally robust but not definitive — and they collide with conventional safety limits at the higher targets.

Key Findings

1. The distinction the question turns on. A dose that lifts the *average* 25(OH)D to a target leaves roughly half the population below it. To get ~97.5% of people *above* a target, you must dose for the slow responders at the bottom of the distribution — a much larger number, because of wide interindividual variability driven by body weight/BMI, baseline status, sun exposure, genetics/VDR, absorption, and assay noise. The canonical illustration: the Institute of Medicine (IOM) concluded that 600 IU/day put 97.5% of people above 20 ng/mL (50 nmol/L), but Veugelers & Ekwaru (2014, *Nutrients*) showed the IOM had regressed *study averages* instead of individual data, "smoothing out" biological variation. Corrected, "600 IU of vitamin D per day achieves that 97.5% of individuals will have serum 25(OH)D values above 26.8 nmol/L rather than above 50 nmol/L… 8895 IU of vitamin D per day may be needed to accomplish that 97.5% of individuals achieve serum 25(OH)D values of 50 nmol/L or more." Those 26.8 nmol/L and 8,895 IU figures are the headline of the "Big Vitamin D Mistake" debate — though the 8,895 IU value is an extrapolation beyond the studied dose range (⩽2,400 IU/day) and the authors explicitly flagged "caution is warranted." MDPI mdpi

2. Population (>95–97.5% *above* target) flat-daily estimates. The most cited individual-level dataset is GrassrootsHealth (Heaney, Garland, Baggerly, French & Gorham 2015, *Nutrients* 7:1688, n=3,657). Plotting the lower bound of the 95% probability band, "the precise inputs corresponding to these serum 25(OH)D values [20, 30, 40 ng/mL] are 3875, 6201, and 9122 IU/day." Specifically: PubMed Central nih

- **20 ng/mL (50 nmol/L):** ~8,895 IU/day *total intake* (Veugelers & Ekwaru, IOM-data reanalysis) **or** ~3,875 IU/day *supplemental* (GrassrootsHealth). The two reconcile because the GrassrootsHealth regression intersects the y-axis around 34 ng/mL, implying a large baseline from food+sun; Heaney et al. concluded "total intake required to achieve 20 ng/mL in 97.5% of the cohort must be close to 7000 IU per day… we call for the IOM… to designate, as the RDA, a value of approximately 7000 IU per day from all sources." nih PubMed Central
- **30 ng/mL (75 nmol/L): ~6,201 IU/day supplemental** (Heaney/Garland GrassrootsHealth letter).
- **40 ng/mL (100 nmol/L): ~9,122 IU/day supplemental** (Heaney/Garland 2015) and ~**9,600 IU/day supplemental** from the earlier Garland, French, Baggerly & Heaney 2011 (*Anticancer Research* 31(2):607, n=3,667), which found "the supplemental dose ensuring that 97.5% of this population achieved a serum 25(OH)D of at least 40 ng/ml was 9,600 IU/d." The two estimates converge well. GrassrootsHealth separately observed that 94% of participants reached ⩾40 ng/mL at 8,000 IU/day (and only 55% at 2,000 IU/day). Anticancer Research PubMed
- **50 ng/mL (125 nmol/L):** No validated 97.5%-of-population number exists in the literature. Extrapolating the curves implies a dose well above 10,000 IU/day — beyond both the studied dose range and the Endocrine Society's upper bound — so it cannot be responsibly stated as a fixed flat dose.

3. Mean-person flat-daily doses by body weight (Ekwaru, Zwicker, Holick, Giovannucci & Veugelers 2014, *PLoS ONE* 9:e111265; observational regression modeling, n=17,614; original units nmol/L, converted here to ng/mL). These are doses to bring the *average* person in each group to the target:

Target	Normal weight	Overweight	Obese
30 ng/mL (75 nmol/L)	~28 IU/day	~534 IU/day	~1,663 IU/day
40 ng/mL (100 nmol/L)	~2,080 IU/day	~3,065 IU/day	~5,473 IU/day
50 ng/mL (125 nmol/L)	~4,964 IU/day	~6,733 IU/day	~11,272 IU/day
60 ng/mL (150 nmol/L)	~9,858 IU/day	~13,501 IU/day	>20,000 IU/day

(The trivial 28 IU/day for normal-weight at 30 ng/mL reflects that this cohort's no-supplement baseline already averaged ~83 nmol/L; the model is effectively saying the average normal-weight participant was already at the 30 ng/mL target before supplementing.) harvard

4. Obesity multiplier. Ekwaru concluded: "We recommend vitamin D supplementation be 2 to 3 times higher for obese subjects and 1.5 times higher for overweight subjects relative to normal weight subjects" (obese and overweight participants averaged 19.8 and 8.0 nmol/L lower, respectively, P<0.001). For the 40 ng/mL target specifically, the multipliers work out to 1.47× (overweight) and 2.6× (obese). The 2011 Endocrine Society guideline independently advised obese patients receive 2–3× more. PLOS + 2

Side-by-Side Comparison

Source	Threshold	Dose for MEAN person	Dose for ~97.5% ABOVE	Units / basis	Study type
Veugelers & Ekwaru 2014 (*Nutrients*)	20 ng/mL (50 nmol/L)	<600 IU (600 IU → mean 63 nmol/L)	**8,895 IU/day total**	total intake; reanalysis of IOM data	Re-analysis of pooled RCT averages (extrapolated)
Heaney/Garland (GrassrootsHealth) 2015	20 / 30 / 40 ng/mL	—	**3,875 / 6,201 / 9,122 IU/day supplemental** (≈7,000 total for 20)	supplemental; lower 95% band	Observational cohort (self-reported)
Garland et al. 2011 (*Anticancer Res*)	40 ng/mL	—	**9,600 IU/day supplemental**	supplemental; baseline ~3,300 IU all-source	Observational cohort
Ekwaru et al. 2014 (*PLoS ONE*)	30 / 40 / 50 ng/mL	NW **28 / 2,080 / 4,964 IU**; Ob **1,663 / 5,473 / 11,272 IU**	— (means only)	supplemental; by BMI; nmol/L	Observational regression model
Aloia/Talwar 2007	20 / 30 ng/mL	2,000 IU → mean 87 nmol/L	2,000 IU → 95% above 20 ng/mL; only 60% above 30 ng/mL	RCT, postmenopausal Black women	RCT

Source	Threshold	Dose for MEAN person	Dose for ~97.5% ABOVE	Units / basis	Study type
Gallagher (dose-response RCTs)	20 / 30 ng/mL	~5.2 ng/mL rise per 1,000 IU (BMI<30)	800 IU → 97.5% above 20 ng/mL (Black women); ~1,600 IU for ⩾30 ng/mL	RCT, older women by race/BMI	RCT
VITAL 2020	30 / 40 ng/mL	2,000 IU/day	>90% ⩾30 ng/mL; 53% ⩾40 ng/mL	RCT, older US adults, baseline mean 30.8 ng/mL	RCT
IOM 2011	20 ng/mL	EAR 400 IU → 16 ng/mL	RDA 600 IU/day (claim later disputed)	flat daily	Guideline (pooled averages)
Endocrine Society 2011	30 ng/mL	—	1,500–2,000 IU/day maintenance; 2–3× if obese	flat daily	Guideline

Details

The IOM error and its correction. The IOM (2011) set the RDA at 600 IU/day (ages 1–70; 800 IU/day for >70), corresponding to "at least 20 ng/ml (50 nmol/liter)… [meeting] the requirements of at least 97.5% of the population," with an Estimated Average Requirement (EAR) of 400 IU/day (≈16 ng/mL, the median person) and a Tolerable Upper Intake Level (UL) of 4,000 IU/day. Veugelers & Ekwaru showed the IOM regressed 32 study *averages* rather than individual data, so the lower prediction limit described study-average variability, not person-to-person variability. Heaney, Garland, Baggerly, French & Gorham (2015) confirmed the direction using GrassrootsHealth individual data, deriving 3,875 / 6,201 / 9,122 IU/day supplemental for 97.5% above 20 / 30 / 40 ng/mL. PubMed Central + 3

RCT-grounded checkpoints. Randomized data anchor the lower targets and the obesity/race effects, though few trials dosed high enough to define the 97.5% point for 40–50 ng/mL:

- **Aloia/Talwar (2007):** In 104 postmenopausal African American women, 2,000 IU/day raised mean 25(OH)D to 87.3 nmol/L; "all participants achieved a serum 25(OH)D concentration >35 nmol/L, 95% achieved a concentration >50 nmol/L, but only 60% achieved a concentration >75 nmol/L" — a clean demonstration that the same dose that nearly maximizes the 20 ng/mL pass rate leaves 40% short of 30 ng/mL. PubMed

- **Gallagher's dose-response RCTs:** estimated 800 IU/day got 97.5% of Black women above 20 ng/mL and ~1,600 IU/day to reach ⩾30 ng/mL; mean rise ~5.2 ng/mL per 1,000 IU in adults with BMI<30 vs ~4.1 ng/mL in BMI>30.
- **VITAL (2020):** With 2,000 IU/day in older US adults (baseline mean 30.8 ± 10.0 ng/mL), after one year ">90% of participants [achieved] 25(OH)D levels of 30 ng/mL or higher and 53% achieving levels that were 40 ng/mL or higher" — consistent with the modeled "mean ≈ 40 ng/mL near 2,000 IU" figure. (ScienceDirect)

Dose-response is curvilinear and plateaus. Ekwaru found "serum 25(OH)D increased by 12.0 nmol/L per 1,000 IU in the supplementation interval of 0 to 1,000 IU per day and by 1.1 nmol/L per 1,000 IU in the supplementation interval of 15,000 to 20,000 IU per day." So chasing high targets in the last unresponsive few percent of a population takes disproportionately large doses — and the curve flattens fastest in lean people and most slowly (i.e., keeps climbing) in obese people at very high intakes. (nih)

Guidelines context and the 2024 reversal. The 2011 Endocrine Society guideline targeted >30 ng/mL, recommended 1,500–2,000 IU/day maintenance for adults (UL 10,000 IU/day), and noted obese patients need 2–3× more. The 2024 Endocrine Society guideline (Demay et al., *JCEM*, Aug 2024) reversed course for generally healthy adults under 75: it "suggests against empiric vitamin D supplementation above the recommended dietary reference intake with the goal of lowering the risk of disease in healthy adults younger than 75 years," tells healthy adults to follow the IOM RDA of 600 IU/day, and recommends against routine 25(OH)D testing — explicitly because no trial defined an optimal target 25(OH)D level. This is a direct philosophical clash with the GrassrootsHealth/Heaney camp, and it is important the reader sees it: mainstream endocrinology in 2024–2026 does **not** endorse dosing the population to 30–50 ng/mL at all. (Endocrine News + 2)

Recommendations

Stage 1 — Decide whose 25(OH)D you are targeting. If your aim is the *median/average* person:

- ~1,000–2,000 IU/day reliably gets most normal-weight adults to 30 ng/mL.
- ~2,000 IU/day brings the average normal-weight adult to ~40 ng/mL (corroborated by both Ekwaru's model and VITAL).
- ~5,000 IU/day brings the average normal-weight adult to ~50 ng/mL.

Stage 2 — If you must get nearly everyone (>95%) above a floor, budget (supplemental, normal weight):

- ~4,000 IU/day for **20 ng/mL**,
- ~6,200 IU/day for **30 ng/mL**,
- ~9,100–9,600 IU/day for **40 ng/mL**. Note that the 30 and 40 ng/mL population doses **exceed the IOM UL (4,000 IU/day)** and the 40 ng/mL dose approaches the Endocrine Society UL (10,000 IU/day). Do not treat these as routine self-dosing recommendations.

Stage 3 — For 50 ng/mL across a whole population: do **not** pursue a fixed high flat dose. The required dose is unvalidated, likely >10,000 IU/day, and exceeds safety guidance. Use measured, supervised test-and-adjust dosing if an individual genuinely needs that level.

Obese adults: multiply the normal-weight dose by ~1.5× (overweight) to 2–3× (obese). E.g., for an average obese adult to reach 40 ng/mL, ~5,500 IU/day; to get nearly all obese adults above 40 ng/mL would require doses beyond conventional safety ceilings.

Best practice over fixed dosing: because response varies ~10-fold across individuals at a given dose, the operationally correct approach is: measure baseline 25(OH)D → supplement → retest at 3–6 months → adjust. Ensure adequacy of cofactors (magnesium, vitamin K2); take with a fat-containing meal (improves absorption by roughly a third).

Thresholds that should change the plan: stop escalating and cut back if serum approaches ~100 ng/mL or if serum/urine calcium rises; if a person remains below target despite high doses, investigate adherence, malabsorption, and BMI before escalating further.

Caveats — What This Does NOT Show

- **Evidence tiering.** The headline *population* numbers (Veugelers & Ekwaru; Heaney/Garland; Ekwaru BMI model; Garland 2011) are from **observational or regression-modeled data**, not RCTs, and the GrassrootsHealth registry relies on **self-reported intake** — a real limitation for precision. The 8,895 IU figure is an **extrapolation** beyond the studied dose range. **RCT data** (Aloia, Gallagher, VITAL) confirm the *direction*, the curvilinear shape, and the obesity/race effects, but seldom tested doses high enough to define the 97.5% point for 40–50 ng/mL. Treat the "well-established" tier as: (a) the mean-person doses near 1,000–2,000 IU for 30–40 ng/mL, and (b) the obesity multiplier. Treat as "extrapolated/contested": the ≥6,000 IU population doses for 30–40 ng/mL and anything for 50 ng/mL.
- **These are not safety endorsements.** The doses needed to get a whole population to 40–50 ng/mL exceed the IOM UL (4,000 IU/day) and approach or exceed the Endocrine Society UL (10,000 IU/day). Chronic intake at these levels carries real risk of hypercalcemia and hypercalciuria and should be medically supervised. Adverse effects in the literature generally appear at serum 25(OH)D around 200 nmol/L (~80 ng/mL) and above.
- **Assay variability materially shifts every number here.** Immunoassay vs LC-MS/MS differences, 3-epi-25(OH)D cross-reactivity, and incomplete lab standardization (only ~53% of LC-MS/MS labs met the VDSP ±5% bias criterion in one comparison) can move an individual's apparent status by 10+ nmol/L — enough to reclassify "sufficient" vs "deficient." A "50 ng/mL" target on one assay is not the same as on another.
- **A target population proportion is a population statement, not a personal guarantee.** Because of genuine biological variation (VDR genetics, body composition, absorption), **some individuals will not reach high targets even at high doses**, while others will overshoot. Population guidance is not an individual prescription — which is exactly why the

test-and-adjust approach, not a fixed flat dose, is the defensible strategy for any individual aiming at 40 ng/mL or higher.

- **Baseline and sun exposure dominate.** Every "supplemental" figure assumes some non-zero baseline from food and sun (GrassrootsHealth's regression implied >3,000 IU/day-equivalent baseline). In sun-deprived winter populations the *supplemental* dose to hit a target rises accordingly; in sunny populations it falls. The numbers are not transportable across latitudes and seasons without adjustment.