

Evaluation of Appropriate Doses and Potential Side/Adverse Effects of Doctor-Prescribed Vitamins

Varun Juyal¹, Princi Rawat¹, Saurabh Saklani^{2*}, Shrestha Joshi³, Sanjay Rishishwar⁴, Poonam Rishishwar⁴

¹B. Pharm Student, Faculty of Pharmacy, Maharaja Agrasen Himalayan Garhwal University, Pokhra, Pauri Garhwal-246169, Uttarakhand(India).

²Assistant Professor, Faculty of Pharmacy, Maharaja Agrasen Himalayan Garhwal University, Pokhra, Pauri Garhwal-246169, Uttarakhand(India).

³MSc Advanced Physiotherapy Student, University of Salford, The Crescent, Salford, Greater Manchester, M5 4WT, United Kingdom.

⁴Head and Professor, Faculty of Pharmacy, Maharaja Agrasen Himalayan Garhwal University, Pokhra, Pauri Garhwal-246169, Uttarakhand(India).

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ABSTRACT

Vitamins are essential micronutrients that play critical roles in numerous physiological and biochemical functions of the human body. While dietary intake is usually sufficient to meet daily requirements, clinicians often prescribe vitamin supplements in therapeutic doses for various deficiencies and disease states. However, excessive or prolonged use can lead to adverse outcomes. This review evaluates the recommended therapeutic doses, common side effects, and potential adverse reactions associated with frequently prescribed vitamins.

Key words- Vitamin supplementation, Therapeutic doses, Adverse effects of vitamins, Micronutrient overdose

I. INTRODUCTION

Vitamins are indispensable for maintaining health, supporting immune function, and regulating metabolic pathways. In clinical practice, vitamin supplementation is commonly advised to manage nutritional deficiencies or as adjunct therapy in chronic conditions¹. Nevertheless, irrational or excessive use may lead to toxicity or interactions with concomitant

medications. This article presents a comprehensive review of the doses and safety profiles of commonly prescribed vitamins².

Global Burden of Vitamin Deficiencies

According to WHO and ICMR data, vitamin deficiencies are widespread, especially in developing countries. For instance³, Vitamin D deficiency affects over 70% of the Indian population. Vitamin B12 and folic acid deficiencies are commonly seen in vegetarians and elderly populations⁴.

Classification of Vitamins

1. Water-soluble: B-complex vitamins and Vitamin C
2. Fat-soluble: Vitamins A, D, E, and K

Role in Disease Prevention

Vitamins contribute to the prevention of chronic diseases such as:

1. Cardiovascular disease (e.g., folic acid)
2. Neurological disorders (e.g., B12, B6)
3. Bone disorders (e.g., Vitamin D and calcium metabolism)

| Vitamin | Absorption | Transport | Storage | Excretion | Mechanism of Action |
|---------|-----------------|---------------------------------|-----------------------|-----------|-------------------------------------|
| A | Small intestine | Retinol-binding protein | Liver | Feces | Gene expression regulation |
| D | Fat-dependent | DBP (Vitamin D-binding protein) | Liver, adipose tissue | Bile | Enhances calcium absorption via VDR |
| E | Fat-dependent | Lipoproteins | Adipose tissue | Bile | Antioxidant membrane protection |
| K | Fat-dependent | Lipoproteins | Liver | Feces | Coenzyme in clotting |

| | | | | | |
|--------|---------------------------|-------------------|---------|-------|--------------------------------------|
| | | | | | factor synthesis |
| C | Active transport | Free | Minimal | Urine | Collagen synthesis, antioxidant |
| B1 | Active transport | Free | Minimal | Urine | Cofactor in carbohydrate metabolism |
| B6 | Passive diffusion | Albumin | Minimal | Urine | Cofactor in amino acid metabolism |
| B12 | Intrinsic factor-mediated | Transcobalamin II | Liver | Urine | DNA synthesis, neurological function |
| Folate | Active transport | Bound | Liver | Urine | DNA synthesis, methylation |

Vitamin Dose and Safety Profile

➤ Vitamin A (Retinol)

Vitamin A is crucial for vision, especially in low light (via rhodopsin synthesis), and is also important for maintaining epithelial integrity, immune function, and reproduction. Its RDA is 700–900 mcg/day, while therapeutic doses can reach 5000–10000 IU/day. It is found in liver, dairy products, egg yolk, and beta-carotene-rich vegetables like carrots and spinach. Deficiency may cause night blindness and xerophthalmia. Overdose can lead to hepatotoxicity, teratogenic effects, alopecia, and bone pain. Children and pregnant women are particularly at risk⁵.

Vitamin A (Retinol)

1. **RDA:** 700–900 mcg/day
2. **Therapeutic Dose:** 5000–10000 IU/day
3. **Indications:** Night blindness, dermatological disorders
4. **Side Effects:** Nausea, headache, irritability
5. **Adverse Effects:** Hepatotoxicity, teratogenicity, alopecia, bone pain

➤ Vitamin D (Cholecalciferol)

Vitamin D regulates calcium and phosphate metabolism and aids in bone mineralization. The RDA is 600–800 IU/day, with therapeutic doses ranging from 1000–5000 IU/day or 60,000 IU weekly. It is synthesized in the skin via sunlight exposure and is found in fortified milk, egg yolk, and fish oil. Deficiency leads to rickets in children and osteomalacia in adults, while toxicity may cause hypercalcemia, nephrocalcinosis, and soft tissue calcification. Elderly individuals and those with limited sun exposure are high-risk groups⁶.

Vitamin D (Cholecalciferol)

1. **RDA:** 600–800 IU/day
2. **Therapeutic Dose:** 1000–5000 IU/day or 60,000 IU weekly

3. **Indications:** Osteoporosis, hypovitaminosis D, rickets, osteomalacia

4. **Side Effects:** Generally well tolerated

5. **Adverse Effects:** Hypercalcemia, nephrocalcinosis, soft tissue calcification

➤ Vitamin E (Tocopherol)

Vitamin E is a powerful antioxidant that protects cell membranes from oxidative damage. The RDA is 15 mg/day, and therapeutic doses range from 400–800 IU/day. It is abundant in nuts, seeds, vegetable oils, and green leafy vegetables. It is used in antioxidant therapy and some skin and reproductive disorders. Side effects may include fatigue and GI upset, while high doses can increase bleeding risk, especially in patients taking anticoagulants^{7,8}.

Vitamin E (Tocopherol)

1. **RDA:** 15 mg/day
2. **Therapeutic Dose:** 400–800 IU/day
3. **Indications:** Antioxidant support, dermatological conditions, infertility
4. **Side Effects:** Fatigue, gastrointestinal upset
5. **Adverse Effects:** Increased bleeding tendency, especially with anticoagulants

➤ Vitamin K (Phylloquinone)

Vitamin K is essential for the synthesis of clotting factors II, VII, IX, and X. The RDA is 90–120 mcg/day, and therapeutic doses are 1–10 mg/day. It is found in green leafy vegetables, broccoli, and is also produced by gut flora. It is used in bleeding disorders, warfarin reversal, and neonatal prophylaxis. Although generally safe, IV administration may cause anaphylaxis. At-risk groups include newborns and individuals on long-term antibiotics⁹.

Vitamin K (Phylloquinone)

1. **RDA:** 90–120 mcg/day
2. **Therapeutic Dose:** 1–10 mg/day

3. **Indications:** Bleeding disorders, vitamin K deficiency, neonatal prophylaxis
4. **Side Effects:** Flushing, taste disturbances
5. **Adverse Effects:** Anaphylaxis (with IV use)

➤ **Vitamin C (Ascorbic Acid)**

Vitamin C functions as an antioxidant and is vital for collagen synthesis, immune function, and iron absorption. The RDA is 65–90 mg/day, with therapeutic doses between 500–1000 mg/day. It is found in citrus fruits, tomatoes, and berries. Deficiency causes scurvy, while overdose may lead to kidney stones and GI upset. Smokers and elderly individuals are particularly susceptible to deficiency¹⁰.

Vitamin C (Ascorbic Acid)

1. **RDA:** 65–90 mg/day
2. **Therapeutic Dose:** 500–1000 mg/day
3. **Indications:** Scurvy, immunity support, common cold
4. **Side Effects:** Abdominal cramps, diarrhea
5. **Adverse Effects:** Kidney stones, hemolysis in G6PD deficiency

➤ **Vitamin B1 (Thiamine)**

Thiamine acts as a coenzyme in carbohydrate metabolism (TPP-dependent enzymes). The RDA is 1.1–1.2 mg/day, and therapeutic doses range from 10–100 mg/day. It is present in whole grains, pork, and legumes. Deficiency causes beriberi and Wernicke's encephalopathy, especially in alcoholics. Adverse effects are rare but can include anaphylaxis when given intravenously¹¹.

Vitamin B1 (Thiamine)

1. **RDA:** 1.1–1.2 mg/day
2. **Therapeutic Dose:** 10–100 mg/day
3. **Indications:** Wernicke's encephalopathy, chronic alcoholism
4. **Side Effects:** Rare
5. **Adverse Effects:** Anaphylaxis (rare, IV form)

➤ **Vitamin B2 (Riboflavin)**

Riboflavin participates in redox reactions as part of FAD and FMN coenzymes. The RDA is 1.1–1.3 mg/day, with therapeutic doses of 5–50 mg/day. Found in milk, eggs, and meat, its deficiency causes symptoms like glossitis and cheilitis. Yellow-orange urine is a benign side effect; toxicity is rare¹².

Vitamin B2 (Riboflavin)

1. **RDA:** 1.1–1.3 mg/day
2. **Therapeutic Dose:** 5–50 mg/day
3. **Indications:** Migraine prophylaxis, deficiency states
4. **Side Effects:** Yellow-orange urine
5. **Adverse Effects:** Rare

➤ **Vitamin B3 (Niacin)**

Niacin is a precursor for NAD/NADP and is involved in energy metabolism. The RDA is 14–16 mg/day; therapeutic doses can go up to 2000 mg/day. Found in meat, legumes, and peanuts, it prevents pellagra and is used to manage hyperlipidemia. Side effects include flushing and itching, while hepatotoxicity, hyperuricemia, and hyperglycemia may occur at high doses¹¹.

Vitamin B3 (Niacin)

1. **RDA:** 14–16 mg/day
2. **Therapeutic Dose:** 100–2000 mg/day
3. **Indications:** Hyperlipidemia, pellagra
4. **Side Effects:** Flushing, pruritus
5. **Adverse Effects:** Hepatotoxicity, hyperglycemia, hyperuricemia

➤ **Vitamin B5 (Pantothenic Acid)**

This vitamin is a component of Coenzyme A, vital for fatty acid metabolism. The RDA is 5 mg/day, and therapeutic doses range from 10–100 mg/day. It is widely distributed in foods like eggs, liver, and whole grains. Deficiency is rare, and no significant toxicities are reported¹².

Vitamin B5 (Pantothenic Acid)

1. **RDA:** 5 mg/day
2. **Therapeutic Dose:** 10–100 mg/day
3. **Indications:** Deficiency states, wound healing
4. **Side Effects:** GI upset
5. **Adverse Effects:** None reported

➤ **Vitamin B6 (Pyridoxine)**

Vitamin B6 is involved in amino acid metabolism and neurotransmitter synthesis. The RDA is 1.3–2 mg/day, with therapeutic use up to 100 mg/day. Found in poultry, fish, bananas, and potatoes, it is used for neuropathy and PMS. High doses (>200 mg/day) may cause sensory neuropathy¹¹.

Vitamin B6 (Pyridoxine)

1. **RDA:** 1.3–2 mg/day
2. **Therapeutic Dose:** 10–100 mg/day

- 3. Indications:** Peripheral neuropathy, PMS, isoniazid-induced deficiency
- 4. Side Effects:** Somnolence, paresthesia
- 5. Adverse Effects:** Sensory neuropathy with chronic doses >200 mg/day

➤ **Vitamin B7 (Biotin)**

Biotin functions as a coenzyme in carboxylation reactions. The RDA is 30 mcg/day, with therapeutic use around 100–300 mcg/day. It is found in egg yolk, nuts, soybeans, and is also synthesized by gut bacteria. Deficiency is rare but may occur in raw egg white consumption or genetic conditions. It may interfere with some laboratory tests¹².

Vitamin B7 (Biotin)

- 1. RDA:** 30 mcg/day
- 2. Therapeutic Dose:** 100–300 mcg/day
- 3. Indications:** Hair/nail health, deficiency
- 4. Side Effects:** Rare
- 5. Adverse Effects:** May interfere with lab tests (e.g., thyroid, troponin)

➤ **Vitamin B9 (Folic Acid)**

Folic acid is essential for DNA synthesis and methylation. The RDA is 400 mcg/day, with therapeutic doses up to 5 mg/day. It is found in leafy greens, legumes, and fortified cereals. It is particularly important in pregnancy to prevent neural tube defects. Overdose may mask Vitamin B12 deficiency¹³.

Vitamin B9 (Folic Acid)

- 1. RDA:** 400 mcg/day
- 2. Therapeutic Dose:** 1–5 mg/day
- 3. Indications:** Pregnancy, megaloblastic anemia, neural tube defect prevention
- 4. Side Effects:** Bloating, nausea
- 5. Adverse Effects:** May mask vitamin B12 deficiency

➤ **Vitamin B12 (Cyanocobalamin)**

Vitamin B12 is necessary for DNA synthesis, nerve function, and red blood cell production. The RDA is 2.4 mcg/day, with therapeutic doses of 500–2000 mcg orally or 1000 mcg monthly IM. Found in animal products, its deficiency causes megaloblastic anemia and neuropathy. High-dose therapy may lead to hypokalemia during early treatment^{14, 15}.

Vitamin B12 (Cyanocobalamin)

- 1. RDA:** 2.4 mcg/day

- 2. Therapeutic Dose:** 500–2000 mcg/day (oral); 1000 mcg/month (IM)
- 3. Indications:** Megaloblastic anemia, neuropathy, vegan diets
- 4. Side Effects:** Injection site pain
- 5. Adverse Effects:** Hypokalemia during initial therapy

4. Clinical Case Studies

- **Case 1:** A 45-year-old woman developed hypercalcemia after 8 weeks of 60,000 IU/week Vitamin D.
- **Case 2:** An alcoholic patient showed rapid neurological improvement after thiamine injection.
- **Case 3:** A vegan elderly developed irreversible neuropathy due to masked B12 deficiency by high-dose folate.
- **Case 4:** A 70-year-old vegan taking high-dose folic acid developed irreversible subacute combined degeneration due to masked Vitamin B12 deficiency.
Lesson: Never supplement folate without evaluating B12 in high-risk groups.
- **Case 5:** A 30-year-old male bodybuilder self-administered Vitamin E 1000 IU/day for 3 months. He presented with bruising and prolonged bleeding after minor injury.
Lesson: Excess Vitamin E can increase bleeding risk, especially with NSAIDs or anticoagulants.
- **Case 6:** A pregnant woman in her first trimester did not receive folic acid supplementation. Ultrasound revealed a neural tube defect (NTD) in the fetus.
Lesson: Early folic acid supplementation (400–800 mcg/day) is essential to prevent NTDs.
- **Case 7:** A 55-year-old diabetic patient using multivitamins developed neuropathy. Lab reports showed high pyridoxine (Vitamin B6) levels. He had been taking 200 mg/day for 6 months.
Lesson: Chronic high-dose B6 causes sensory neuropathy; dosing must be regulated.
- **Case 8:** A 45-year-old woman developed hypercalcemia and fatigue after consuming Vitamin D 60,000 IU/week for 8 weeks without calcium monitoring.
Lesson: Long-term high-dose Vitamin D must be monitored for serum calcium.
- **Case 9:** A chronic alcoholic patient admitted with ataxia and confusion showed rapid neurological improvement within 48 hours of receiving IV thiamine (Vitamin B1).

Lesson: Empiric thiamine is life-saving in Wernicke's encephalopathy.

- **Case 10:** A 28-year-old woman took megadoses of Vitamin C (2000 mg/day) for skin brightening. After 3 months, she presented with renal colic, and imaging confirmed oxalate kidney stones.

Lesson: High-dose Vitamin C increases oxalate excretion and risk of nephrolithiasis.

Special Populations

1. **Pregnancy:** Folic acid (400–800 mcg), Vitamin D
2. **Elderly:** B12, D, calcium
3. **Alcoholics:** Thiamine, folic acid
4. **Bariatric Surgery:** B12, A, D, K supplementation

Regulatory & Prescription Guidelines

1. **ICMR and WHO** recommend evidence-based dosing
2. **Indian Pharmacopoeia** provides formulation standards
3. OTC vs Prescription boundaries need enforcement

II. DISCUSSION

Excessive multivitamin use is rising. Public misbeliefs and self-medication contribute to this. Routine testing for vitamin levels and patient counseling are needed. Personalized vitamin therapy based on laboratory findings can prevent both deficiencies and toxicities.

III. CONCLUSION

Though vitamins are generally safe, their inappropriate use can cause serious side effects. Rational prescription, patient-specific dosing, and continuous monitoring are essential.

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Appendices

- Vitamin dose calculators
- Drug–vitamin interaction chart
- Patient education materials