Vitamin D Fortification & Supplementation

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Dietary Sources of Vit D

Natural Food Sources

Animal origin (vit D3)


Salmon


Mackerel

Tuna


Sardine


Egg yolk

Plant origin (vit D2)


Mushrooms

Few foods naturally contain vit D

Dietary Sources of Vit D

Fortified Foods

Foods commonly fortified with vit D

Different country has different vit D fortification policies

Countries with mandatory fortification policies

- Australia (margarine)
- Sweden (fluid milk products & margarine)
- Canada (fluid milk products & margarine)

Countries with voluntary fortification policies

- **Milk** to contain 2 µg/100 mL (80 IU)
- **Margarine** to contain 26 µg/100 g (1040 IU)

Dietary Sources of Vit D

Supplements

1 µg of vit D = 40 IU

Vit D3

- Irradiation of 7-dehydrocholesterol from lanolin obtained from the wool of sheep

Vit D2

- UV irradiation of ergosterol in yeast

Most evidence shows that vit D3 raises and sustains serum 25OHD levels longer and more effectively than vit D2, despite both being well absorbed

Recommended Dietary Intake/Allowance for Vitamin D

Different country has different dietary guidelines

Terminology

Estimated Average Requirement (EAR)

The average daily intake that **meets the needs of 50% of healthy individuals in a particular age and gender group**

Reference Nutrient Intake (RNI)

- The intake that is **sufficient to meet the needs of 97.5% of the population.**
- Equivalent concept to that of the RDA or RDI

Adequate Intake (AI)

- It is used when an EAR and RNI cannot be determined due to insufficient evidence.
- A recommended intake level based on observed/experimentally determined approximations of nutrient intake.

Recommendation for vit D intake in selected SEA Countries

Country	0-11 months (µg/d)	1-18 years (µg/d)
Malaysia (2017 RNI)	*10	15
Indonesia (2019 RDA)	10	15
Thailand (2020 DRI)	10	15
Philippines (2015 DRI) *Adequate Intake	*5	*5

	3-12 months (µg/d)	1-6 years (µg/d)	7-18 years (µg/d)
Singapore (RDA) Health Promotion Board Singapore	10	Boys: 10 ; Girls: 10.5	2.5

- The set RDA/RNI assumed that individuals have minimal exposure to sunlight

Dietary Guidelines for Americans (2020-2025)

Soon after birth (0-6 months)

- All infants who are fed human milk exclusively / mixed fed (human milk + infant formula) will need a vit D supplement of 400 IU/d (10 µg/d).
- Vit D supplement is not needed for infants receiving full feeds of infant formula.

Country	6-11 months (µg/d)	12-23 months (µg/d)	2-18 years (µg/d)
US RDA	10	15	15

Nutrient Requirements in the UK

Scientific Advisory Committee on Nutrition (SACN) for Vit D (2016)

Country	0-11 months (µg/d)	1-3 years (µg/d)	4 year and above (µg/d)
UK (2016 RNI)	Safe intake: 8.5-10	Safe intake: 8.5-10	10

Advice for infants and young children

Babies from birth to 1 year of age should have a daily supplement containing 8.5 µg to 10 µg of vit D throughout the year if they are:

- **Breastfed**
- **Formula-fed and having less than 500 ml of infant formula/day**

Surveillance Data on Habitual Dietary Vit D Intakes

Vit D intake in selected SEA Countries (SEANUTS II)

% not meeting requirements	0.5-0.9 years	1.0 - 3.9 years	4.0-6.9 years	7.0-12.9 years
Malaysia (Poh et al., 2023)	79.4%	91.6%	92.4%	98.5%
Thailand (Pongcharoen et al., 2023)	NA	86.0	92.8	95.8

Habitual vit D intakes in the population are much lower than the recommendations

Supplementation has been repeatedly shown to be effective in improving vit D status.

But, is it a sustainable strategy at community level?

Challenges in Asia

Socioeconomic barriers & compliance

- Access to and compliance with supplementation can be difficult, especially in low-income regions.

Cultural Preferences

- Dietary supplements are not always culturally accepted

European countries residing above 40°N:

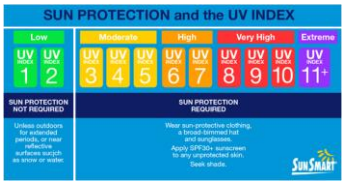
UVB availability is insufficient to enable skin synthesis of vit D for ~ 4 to 7 months (autumn & winter)

Sunlight is abundant in many parts of Asia, but.....

- **Indoor living**
- **Societal preferences for fair skin**
- **Religious attire**
- **Pollution**

Safe sun exposure

- **Outdoor physical activity**
- **Casual/incidental exposure**
- **Important: without sun burning**



Exploring the Possibilities of Food Fortification with Vitamin D

Fortification as a sustainable strategy

- **Fortification is cost-effective and does not rely on daily compliance as supplements do**
  - People naturally consume fortified foods as part of their regular diet

An example of Successful Fortification Program

The positive impact of general vitamin D food fortification policy on vitamin D status in a representative adult Finnish population: evidence from an 11-y follow-up based on standardized 25-hydroxyvitamin D data[1–3]

Tuija Jääskeläinen,[4,12] Suvi T Itkonen,[5,12] Annamari Lundqvist,[4] Maijaliisa Erkkola,[5] Tapani Koskela,[6] Kaisa Lakkala,[6] Kirsten G Dowling,[7] George LJ Hull,[7] Heikki Kröger,[8] Jaro Karppinen,[10,11] Eero Kyllönen,[10] Tommi Härkänen,[4] Kevin D Cashman,[7,8] Satu Männistö,[4] and Christel Lamberg-Allardt[5]*

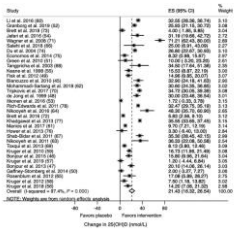
Am J Clin Nutr 2017;105:1512–20. Printed in USA. © 2017 American Society for Nutrition

The Journal of Nutrition
Nutrient Physiology, Metabolism, and Nutrient-Nutrient Interactions

Vitamin D Food Fortification and Biofortification Increases Serum 25-Hydroxyvitamin D Concentrations in Adults and Children: An Updated and Extended Systematic Review and Meta-Analysis of Randomized Controlled Trials

Eleanor Dunlop,[1] Mairead E Kiely,[2] Anthony P James,[1] Tanya Singh,[1] Ngoc Minh Pham,[1,3] and Lucinda J Black[1]

J Nutr 2021;151:2622–2635.



34 publications (N=3930)
2398 adults
- IV: 1345
- Control: 1053

1532 children
- IV: 970
- C: 562

- A treatment effect (WMD) of 21.2 nmol/L (95% CI 16.2, 26.2)
- Fortification with vit D3 more effective than vit D2
- Effect was grater when baseline 25OHD < 50 nmol/L and
- when fortification dose ≥10 µg/d compared to < 10 µg/d
- Heterogeneity was high (I2 = 96%, chi-squared P < 0.001)

Fortification: Important Factors

- **Choosing a suitable food vehicle**

Basic commodities

Ingredients of processed foods

Dietary pattern of the country

Economically available for all segments of the population

Fortification: Important Factors

- **Determination of the effective fortification dose**

Vit D status of the target population

The 25OHD goal concentration that must be attained by fortification

British Journal of Nutrition (2022), 127, 1925–1938

The effects of vitamin D-fortified foods on circulating 25(OH)D concentrations in adults: a systematic review and meta-analysis

Bahareh Nikooyeh and Tirang R. Neyestani*
Laboratory of Nutrition Research, National Nutrition and Food Technology Research Institute, Faculty of Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran

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- An average increase of 2 nmol/l increase in 25OHD concentration for every 100 IU vitamin D intake per day

Fortification: Important Factors

- **Vit D stability & bioavailability**

Stability during processing

- **Regulatory compliance**

Standardisation

- **Clinical validation**

Effectiveness

Safety

Conclusion

- Vit D deficiency remains a pressing public health issue in Asia due to factors such as limited sun exposure, dietary habits and lifestyle changes.
- While supplementation has been beneficial in Europe and is recommended for vulnerable groups, it poses challenges in large-scale implementation in Asia.

Conclusion

- Food fortification presents a practical and sustainable solution that could effectively address vit D deficiency accross diverse populations.
- A comprehensive strategy combining fortification with public education on safe sun exposure and dietary intake will be essential to tackling this issue in Asia.