



POLICY BRIEF #55

Towards Vitamin D Kuposhan Mukht Bharat through Food Fortification

The Role of Food Safety and Standards Authority of India (FSSAI)

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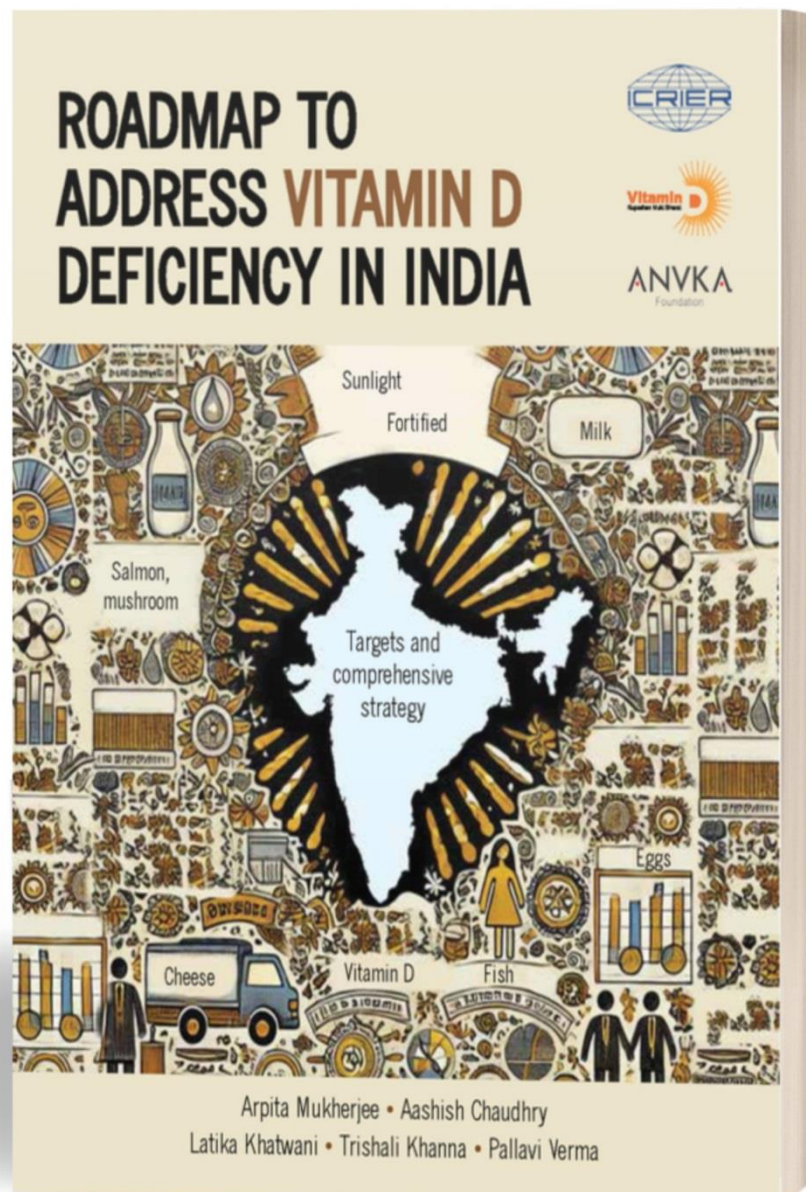


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Abstract

India accounts for nearly half of the world's micronutrient-deficient population. While the country has made significant strides in addressing some micronutrient deficiencies, such as iron and iodine, Vitamin D deficiency remains an overlooked public health challenge. According to ICRIER-ANVKA Foundation 2025 report, titled, "*Roadmap to Address Vitamin D Deficiency in India*", one in every five Indians are Vitamin D deficient. This is despite India receiving abundant sunshine throughout the year and the country being one of the world's largest producers of several Vitamin D-rich foods (such as eggs, milk and fish).

To address Vitamin D deficiency, countries across the world have implemented effective food-fortification measures by selecting appropriate food vehicles tailored to national dietary habits, choosing the right form of Vitamin D (D₂ or D₃), implementing mandatory fortification policies, and ensuring adequate monitoring. In India, the Food Safety and Standards Authority of India (FSSAI) has also taken steps to address Vitamin D deficiency. These include permitting voluntary fortification of edible oil and milk with Vitamin D and establishing the Food Fortification Resource Centre (FFRC) to provide technical assistance, guidance and capacity-building support for the adoption and scaling of food fortification efforts. In spite of these initiatives, there are some gaps in food fortification, such as only edible oil and milk are permitted to be fortified with Vitamin D, fortification is voluntary in nature and only plant-based source of Vitamin D are allowed. These limit the impact of food fortification in addressing Vitamin D deficiency.

This policy-brief outlines key action points that the FSSAI may undertake to support "*Vitamin D Kuposhan Mukh Bharat*". These include permitting a wider range of products to be fortified with Vitamin D from both plant-based and animal-based sources, mandating fortification in select products, strengthening research and innovation in fortification, defining high fat sugar and salt (HFSS), raising awareness and building consumer trust, improving effective monitoring to enhance fortification impact, integrating fortified food into dietary guidelines, and providing capacity-building and training to MSMEs on fortification.

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List of Abbreviations

CBSE	Central Board of Secondary Education
CDSCO	Central Drugs Standard Control Organisation
DoFPD	Department of Food and Public Distribution
EU	European Union
FAO	Food and Agriculture Organization
FFRC	Food Fortification Resource Centre
FSSAI	Food Safety and Standards Authority of India
GAIN	Global Alliance for Improved Nutrition
HFSS	High Fat Salt and Sugar
ICMR-NIN	Indian Council of Medical Research – National Institute of Nutrition
MIB	Ministry of Information and Broadcasting
MoA	Ministry of AYUSH
MoE	Ministry of Education
MoF	Ministry of Finance
MoFPI	Ministry of Food Processing and Industry
MoHFW	Ministry of Health and Family Welfare
MoWCD	Ministry of Women and Child Development
MSMEs	Micro, Small and Medium Enterprises
NLEM	National List of Essential Medicines
NCDs	Non-Communicable Diseases
NDMC	New Delhi Municipal Council
NIFTEM	National Institute of Food Technology, Entrepreneurship and Management
NPPA	National Pharmaceutical Pricing Authority

PHFI	Public Health Foundation of India
QALYs	Quality-Adjusted Life Years
R&D	Research and Development
SAMPADA	Survey for Assessment of Markers of Population Health Activity, Diet and Anthropometry
UK	United Kingdom
UNICEF	United Nations International Children's Fund
USA	United States of America
WFP	World Food Programme
WHO	World Health Organization

Towards Vitamin D Kuposhan Mukht Bharat through Food Fortification *The Role of Food Safety and Standards Authority of India (FSSAI)*

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1. Food – A Key Vehicle to Address Vitamin D Deficiency

As India advances towards achieving nutrition security, micronutrient deficiencies remain a pressing public health concern, with Vitamin D deficiency¹ emerging as a silent epidemic – with one in five Indians suffering from Vitamin D deficiency.² The consequences of this deficiency are significant across all stages of life. Among children and adolescents, it can lead to rickets; among pregnant women, it is linked to poor foetal bone development and among adults, prolonged deficiency can result in osteomalacia and osteoporosis. The symptoms of Vitamin D deficiency often appear only when the deficiency becomes severe, making early prevention and intervention critical.³

Sunlight is the most important natural source of Vitamin D. Yet, despite India receiving abundant sunshine, factors such as increasing pollution, rapid urbanisation, frequent use of sunscreen and indoor lifestyle are reducing natural Vitamin D synthesis,⁴ as evident from rising incidence of Vitamin Deficiency

Vitamin D rich and fortified foods are another source of getting Vitamin D. India is the world's largest producer of Vitamin D-rich foods like milk, and the second-largest producer of eggs and fish (as of 2024).⁵ While these are consumed by many Indians, other foods rich in Vitamin D like salmon, cod liver oil and mushrooms are only consumed by a niche group of the

Sources of Vitamin D



Sunshine: Vitamin D, also known as the 'sunshine vitamin,' is primarily obtained through exposure to sunlight.

Foods: Fish, eggs, mushrooms, cheese, etc., fortified products like milk, margarine, yogurt, juices and cereals.

Vitamin D Supplements: Vitamin D₂ (Ergocalciferol, mostly plant-based) and D₃ (Cholecalciferol, mostly animal-based).

¹ Vitamin D is a vital micronutrient that plays a crucial role in the development, growth and maintenance of a healthy skeletal system throughout an individual's lifespan. The primary role of Vitamin D is to regulate calcium homeostasis, which is crucial for maintaining proper calcium levels and promoting strong bones.

² Mukherjee et al., (2025).

³ Reddy, (2020); Nitish et al., (2024); Bhadada et al., (2021).

⁴ Gupta et al. (2014); Aparna et al. (2018); Khadiilkar et al. 2022; Puri et al. (2007).

⁵ <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2114715>; <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2086052>; <https://www.pib.gov.in/FactsheetDetails.aspx?Id=149135> (Last accessed on July 23, 2025).

population and are not part of the regular Indian diet. Moreover, around 30 per cent of the Indian population is vegetarian,⁶ while many naturally Vitamin D-rich foods are animal-based.

2. Food Fortification: A Scalable Solution to Address Micronutrient Deficiencies

Food fortification offers a scalable and cost-effective solution to address multiple micronutrient deficiencies, (including Vitamin D deficiency).⁷ It seamlessly enhances the nutritional value of everyday diets, offering vital health benefits without requiring people to change their eating habits. As food consumption is naturally self-limiting, fortification is considered a safe and reliable approach, which increases nutrition without risk of toxicity.⁸

Global best practices for Vitamin D food fortification involve a combination of selection of appropriate food vehicles tailored to national dietary habits, choosing the right form of Vitamin D (D₂ or D₃), implementing mandatory fortification policies and ensuring adequate monitoring.

2.1. Suitable Food Vehicles for Fortification

International organisations such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the United Nations International Children's Fund (UNICEF) recommend large-scale food fortification programmes to address multiple micronutrient deficiencies. For example, UNICEF’s 2023 guidelines on “*Large-scale Food Fortification for Prevention of Micronutrient Deficiencies in Children, Women and Communities*”, recommends wheat flour, maize flour, rice, oil and milk as appropriate vehicles for multiple micronutrients fortification, along with Vitamin D (see Table 1).

Table 1: Potential Food Vehicles and their Fortifiable Micronutrients

Food Vehicle	Vitamins and Minerals (Fortificant) that can be Added
Wheat Flour	Iron, Zinc, Selenium, Vitamins A, D, B ₁ (Thiamine), B ₂ (Riboflavin), B ₃ (Niacin), B ₆ (Pyridoxine), B ₉ (Folate or Folic Acid) and B ₁₂ (Cobalamin).
Maize Flour	Iron, Zinc, Vitamins A, D, B ₁ (Thiamine), B ₂ (Riboflavin), B ₃ (Niacin), B ₆ (Pyridoxine), B ₉ (Folate or Folic Acid) and B ₁₂ (Cobalamin).
Rice	Iron, Zinc, Selenium, Vitamins A, D, B ₁ (Thiamine), B ₂ (Riboflavin), B ₃ (Niacin), B ₆ (Pyridoxine), B ₉ (Folate or Folic Acid) and B ₁₂ (Cobalamin).
Salt	Iodine and, under special cases, fluoride, iron and folic acid.
Oil	Vitamins A, D and E.
Milk	Vitamins A, D, Iron and Folic Acid.

Source: UNICEF (2023).

⁶ <https://dhsprogram.com/pubs/pdf/FR375/FR375.pdf> (Last accessed on July 16, 2025).

⁷ WHO and FAO (2006).

⁸ Roth et al., 2018.

Globally, countries such as the United States of America (USA), the United Kingdom (UK), Canada, Bangladesh, have fortified wide range products such as breakfast cereals, margarine, milk, cheese, fat spreads, flour, yogurt, juices, biscuits, and breads with Vitamin D.⁹ In 2013, in Brazil, 114 out of 535 food products available in market were found to be fortified or enriched with Vitamin D.¹⁰

Several studies have highlighted that consumption of fortified food improves the Vitamin D levels. For example, in 2003, in the USA, Tangpricha et al. (2003) found that individuals who consumed fortified orange juice over a 12-week period recorded 150% increase in Vitamin D levels. The study reported a mean increase of 22.8 ± 2.8 units of Vitamin D and notably, none of the participants in the intervention group were Vitamin D deficient at the end of the study period. In 2011, in Bangladesh, Adams et al., (2017) found that daily consumption of a 75g packet of fortified biscuits enriched with essential micronutrients (including Vitamin D) led to 1.1 times increase in mean serum 25-hydroxyvitamin D [25(OH)D] levels compared to the baseline level.

2.2. Form of Fortification: Vitamin D₂ or D₃?

Vitamin D₃ is considered significantly more effective and potent than Vitamin D₂ in improving and maintaining Vitamin D levels for a longer period of time.¹¹ For example, in 2017, in the UK, Tripkovic et al. (2012) tested the effects of daily doses of Vitamin D₂ and D₃ over 12 weeks in a group of 335 healthy women. The study found that Vitamin D₃ increased blood Vitamin D levels by around 74%, while D₂ only increased them by about 33%. Another study, in 2022, in Qatar, by Albarri et al. (2022) also found that Vitamin D₃ increased serum Vitamin D levels nearly twice in comparison to Vitamin D₂, even at a lower dose.

Vitamin D, also known as calciferol, exists in two forms:

- Vitamin D₂ or ergocalciferol, mostly found in plant-based sources.
- Vitamin D₃ or cholecalciferol, mostly found in animal-based sources.

2.3. Mandatory v/s Voluntary Fortification

Fortification can be voluntary or mandatory. Global studies found that voluntary fortification relies on industry discretion and often results in limited coverage and public health impact. In contrast, mandatory fortification ensures consistent and equitable nutrient access across the entire population.¹² Therefore, several countries have adopted large-scale, national-level mandatory fortification programmes to address micronutrient deficiencies such as Vitamin D. For example, since 1965, Canada has mandated the fortification of milk with Vitamin D. As a result, dairy products alone contribute nearly 49.1% of the population's daily Vitamin D

⁹ Jääskeläinen et al., (2017); Dhaussy, (2014); Calvo et al., (2004); Iossifidis et al., (2021).

¹⁰ Martins et al. (2024).

¹¹ Van Den Heuvel et al, (2024).

¹² OECD, 2024.

intake.¹³ In 2007, Sweden mandated Vitamin D fortification of low-fat milk and margarine.¹⁴ In 2009, Jordan introduced mandatory fortification of wheat flour with Vitamin D.¹⁵

The success of mandatory fortification depends not only on regulation but also on regular monitoring.¹⁶ Countries worldwide revise their fortification standards to align with evolving scientific research and public health data. For example, in 2022, Canada updated its policy to double the dosage of Vitamin D content in milk to 80 IU per 100 ml, based on updated nutritional assessments and population needs.¹⁷ In 2018, Sweden revised its Vitamin D content in low-fat milk from 0.95-1.10 µg per 100 g (equivalent to approximately 38–44 IU), in response to rising Vitamin D deficiency and changing consumption patterns.¹⁸

While Vitamin D fortification is not yet mandatory in India, example of mandatory salt fortification/iodized salt has shown that around 92 per cent of the Indian population consumes iodized salt,¹⁹ which has helped to address iodine deficiency. By 2020, 123 out of 150 WHO member countries, including India, had adopted mandatory salt iodization. Zimmermann et al. (2021) highlighted that those countries with mandatory salt iodization achieved a household coverage increase from 49% to 72%, compared to 40% to 49% increase in countries which relied on voluntary iodization. Thus, overall, mandatory fortification shows better results than voluntary fortification, but it may face industry opposition or implementation issues. In case of India, which has a large production of milk and fortified milk and oil are mandated through the public distribution system, moving towards mandatory fortification may not be a major issue, if industry can be on boarded into the initiative.

2.4. Positive Health and Economic Impact of Fortification

Studies have shown the positive health and economic impact of Vitamin D fortification in reducing the burden of Vitamin D deficiency and related diseases, improving quality adjusted life years (QALYs)²⁰ and generating annual net cost savings for health and social care systems. For example, in 2019, in England and Wales, Aguir et al. (2019) estimated that consuming Vitamin D fortified wheat flour (with 400 IU of Vitamin D per 100 grams) could prevent approximately 9.9 million cases of Vitamin D deficiency and result in a gain of 1.75 million QALYs. In 2015, in France, Hiligsmann et al., (2016) and Hiligsmann & Reginster, (2017) found that daily consumption of two Vitamin D-fortified dairy products can prevent approximately

¹³ Vatanparast et al., 2010.

¹⁴ <https://www.gov.uk/government/publications/fortifying-food-and-drink-with-vitamin-d-a-sacr-rapid-review/fortifying-foods-and-drinks-with-vitamin-d-main-report> (Last accessed on September 08, 2025).

¹⁵ Rowe et al., 2018.

¹⁶ Lalani et al., 2019.

¹⁷ <https://www.canada.ca/en/health-canada/services/fortified-food/canadas-approach.html> (Last accessed on September 07, 2025).

¹⁸ <https://www.gov.uk/government/publications/fortifying-food-and-drink-with-vitamin-d-a-sacr-rapid-review/fortifying-foods-and-drinks-with-vitamin-d-main-report> (Last accessed on September 08, 2025).

¹⁹ <https://fortification.fssai.gov.in/commodity?commodity=double-fortified-salt> (Last accessed on September 08, 2025).

²⁰ QALYs measure both the quantity and quality of life lived. One QALY equals one year of life in perfect health. It is calculated by multiplying the number of additional years of life by the health-related quality of life (HRQL) score, which ranges from 0 (equivalent to death) to 1 (perfect health). QALYs are useful for comparing different types of health interventions – for example, one that extends life but with side effects, and another that improves the quality of life without increasing lifespan.

64,932 fractures, including 19,500 hip fractures, among the population over 60 years of age, and can result in gain of 23,067 QALYs. In 2015, in Germany, Sandmann et al. (2015) reported that fortification of bread (with 444 IU of Vitamin D per 100g) could lead to annual net cost savings of €315 million (USD 337.05 million) for health and social care systems healthcare system and prevent 36,705 fractures among women aged 65 and older.

To summarise, global examples of best practices for Vitamin D food fortification involve a combination of government-led policy, robust monitoring, and the selection of appropriate food vehicles tailored to national dietary habits. Successful programmes often rely on mandatory fortification, which is considered more effective than voluntary or market-driven approaches.

3. The Food Safety and Standards Authority of India's (FSSAI) Efforts to Address Vitamin D Deficiency



Under the *Food Safety and Standards (Fortification of Food) Regulation, 2018*,²¹ voluntary fortification of milk and edible oil with plant-based sources of Vitamin D is permitted. This regulation also mandates the distribution of fortified milk and edible oil through public food distribution schemes (such as Mission POSHAN 2.0). In addition, all fortified foods are required to carry the “+F” logo, in accordance with specifications set forth in Schedule-II of the regulation. The logo makes it easy for consumers to make informed choices and encourage the consumption of fortified foods.

Several food products (like packaged juices and cereals) are now available in food stores and non-store retail formats and are marketed as “Vitamin D Enriched” [allowed under FSSAI’s Food Safety and Standards (Advertising and Claims) Regulation 2018].²² However, these enriched products are typically priced at a premium, which limits their accessibility and affordability for the wider population.

Fortification refers to the practice of adding micronutrients that may not have been present originally to a food product, while enrichment means adding back micronutrients that were lost during processing, essentially restoring the nutritional value to its original state.

- FAO and WHO 1994

To scale up fortification in India, FSSAI established the Food Fortification Resource Centre (FFRC)²³ in 2017 with support from Tata Trusts. It has also collaborated with multiple stakeholders, including the Ministry of Women and Child Development (MoWCD), Ministry of

²¹ https://www.fssai.gov.in/upload/uploadfiles/files/Gazette_Notification_Food_Fortification_10_08_2018.p df (Last accessed August 17, 2025).

²² https://fssai.gov.in/upload/uploadfiles/files/Compendium_Advertising_Claims_Regulations_04_03_2021.p df (Last accessed on August 26, 2025).

²³ https://fssai.gov.in/upload/knowledge_hub/1263185b34be739fe02Food_per_cent20Fortification.pdf (Last accessed on August 8, 2025).

Education (MoE), Department of Food and Public Distribution, (DoFPD), NITI Aayog, Global Alliance for Improved Nutrition (GAIN), World Food Programme (WFP) and the Gates Foundation,²⁴ to provide technical assistance, guidance, and capacity-building support for the adoption and scaling of food fortification in India.

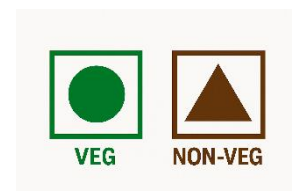
Beyond fortification, FSSAI has also launched awareness campaigns to address Vitamin D deficiency. In 2018, FSSAI partnered with the New Delhi Municipal Council (NDMC) and the Central Board of Secondary Education (CBSE) to launch “*Project Dhoop*”.²⁵ The campaign encouraged schools in Delhi to shift their morning assemblies to between 11 a.m. and 1 p.m. to ensure maximum Vitamin D synthesis through sun exposure. The campaign highlighted the role of sunlight in preventing Vitamin D deficiency and promoted the consumption of Vitamin D fortified food products.

In spite of these initiatives, there are some gaps in food fortification, such as only limited range of products are permitted to be fortified with Vitamin D, fortification is voluntary in nature and not mandatory and only plant-based source of Vitamin D is allowed — all of these limit the impact of food fortification in addressing Vitamin D deficiency.

4. Strengthening Food Fortification to Support “*Vitamin D Kuposhan Mukht Bharat*”

The FSSAI may consider the following to address the gaps in food fortification:

- **Allow more products to be fortified with Vitamin D:** To improve population-level intake of Vitamin D, the Scientific Panel on Nutrition and Fortification may consider extending fortification from milk and edible oil to other staples that are commonly available and widely consumed by masses like wheat, rice, maize, etc., in line with UNICEF’s 2023 Guidelines on Large-Scale Food Fortification (see Table 1), global best practices and taking into account the Indian dietary preferences. However, FSSAI has to ensure that when multiple fortified foods are consumed together, the combined intake remains within safe limits and does not pose a risk of toxicity.
- **Permit the use of both Plant-Based and Animal-Based Source of Vitamin D:** Currently, Vitamin D fortification in India is limited to plant-based sources, even though animal-based sources are more effective in improving Vitamin D status. Vitamin D₃ (mostly derived from animal-based sources) is included in the National List of Essential Medicines (NLEM). In this regard, the FSSAI may consider permitting both plant-based and animal-based source of Vitamin D for fortification, with clear declaration of the



²⁴ <https://www.tatatrusters.org/our-work/nutrition/policy-and-advocacy/supporting-the-food-fortification-resource-centre> (Last accessed on August 26, 2025).

²⁵ https://www.fssai.gov.in/upload/media/5b446ea866837FSSAI_News_Dhoop_WebIndia_31_03_2018.pdf (Last accessed on August 12, 2025).

source of Vitamin D through appropriate vegetarian or non-vegetarian symbols [under the Food Safety and Standards (Labelling and Display) Regulations, 2020]²⁶.

- **Mandate fortification for select products:** FSSAI has permitted the voluntary fortification of edible oil and milk with Vitamin D and mandated its distribution through public food procurement schemes (like PM POSHAN, Mission Poshan 2.0, etc.). Edible oil is consumed by all socio-economic group of the population and India is one of the world's largest producers of milk, so the fortification of these products are correct decisions. However, the overall impact has been limited because voluntary fortification depends on industry uptake, whereas mandatory fortification ensures uniform coverage. Therefore, FSSAI may consider mandatory fortification of these two products. Further, FSSAI may consider multiple micronutrients fortification including Vitamin D, in widely consumed staples like wheat, rice, maize (see Table 1).
- **Strengthen research and innovation in fortification:** As India advances in food technology, FSSAI may play a vital role in supporting research on bioavailability, stability and safe dosage of Vitamin D in different food vehicles. By collaborating with research institutions like NIFTEM, Central Food Technological Research Institute (CFTRI) and other food technology institutions, FSSAI can provide regulatory guidance, facilitate product approvals and create an enabling environment for newly developed fortified products to reach the market responsibly and at scale.
- **Defining high fat sugar and salt (HFSS) category to promote healthy choices:** While supporting fortification, FSSAI may also need to ensure that fortification is not concentrated in products that are high in salt, fat and/or sugar. With rising incidences of obesity and related non-communicable diseases (NCDs) in India, FSSAI may consider developing a clear and uniform definition of HFSS foods. This will help consumers to make informed decisions and guide industry to reformulate products responsibly.
- **Raise awareness and build consumer trust:** FSSAI can use its initiatives like "*Eat Right India*" to create awareness about the role of fortification in overcoming micronutrient deficiencies among different population groups - school children, adolescents, working persons, and so on. It may develop infographics (posters, videos, etc.) to highlight the benefits of fortification, clarify safe consumption levels and assure consumers about the safety and effectiveness of fortified foods. Further in collaboration with the Ministry of Information and Broadcasting (MIB), these materials can be disseminated through radio, television, community outreach networks and social media to ensure maximum reach.
- **Effective monitoring to strengthen fortification impact:** Effective fortification requires not only regulatory compliance but also proper monitoring and continuous impact assessment. FSSAI may leverage the data from India's first nationwide diet and bio-mark survey - Survey for Assessment of Markers of Population health, Activity, Diet and

²⁶ https://fssai.gov.in/upload/uploadfiles/files/Comp_Labelling.pdf (Last accessed on September 08, 2025).

Anthropometry (SAMPADA), conducted by ICMR–NIN, to identify high-risk groups and regions most vulnerable to Vitamin D deficiency. Further, robust scientific data should be generated by conducting surveys to assess the effectiveness of consumption of fortified foods in improving the micronutrient status. These surveys can help assess the efficacy of fortification dosages, evaluate safety when multiple fortified foods are consumed, and generate evidence to guide the re-evaluation and refinement of standards. Such an approach would ensure that fortification remains effective, safe, and aligned with India’s nutritional priorities.

- **Integrate fortified food into dietary guidelines:** FSSAI may work with ICMR–NIN to include an addendum in the *2025 Dietary Guidelines*. In addition to recommending sun exposure, the addendum could also highlight the role of Vitamin D-rich and fortified food and safe sun exposure practices. This will ensure that the guidelines provide a more comprehensive strategy to address Vitamin D deficiency in India.
- **Capacity-building and training to MSMEs on fortification:** FSSAI, in collaboration with MoFPI may provide capacity building and training to Micro, Small and Medium Enterprises (MSMEs), manufacturers and cooperatives to adopt and implement fortification. This may include crating manual and guidelines, conducting training, and affordable access to premix and testing facilities.

5. Conclusion

By leveraging food as a vehicle for nutrition security, FSSAI can transform the fight against Vitamin D deficiency from fragmented initiatives into a co-ordinated national strategy. In doing so, it can help safeguard India’s human capital and advance the vision of a “*Vitamin D Kuposhan Mukh Bharat*”, contributing significantly to the country’s broader goals under *Viksit Bharat @2047*.

References

- Adams, A. M., Ahmed, R., Latif, A. H. M. M., Rasheed, S., Das, S. K., Hasib, E., Farzana, F. D., Ferdous, F., Ahmed, S., & Faruque, A. (2017).** Impact of fortified biscuits on micronutrient deficiencies among primary school children in Bangladesh. *Public Library of Science (PLOS) ONE*, 12(4), e0174673. <https://doi.org/10.1371/journal.pone.0174673> (Last accessed on August 16, 2025).
- Aguiar, M., Andronis, L., Pallan, M., Högl, W., & Frew, E. (2019).** The economic case for prevention of population Vitamin D deficiency: a modelling study using data from England and Wales. *European Journal of Clinical Nutrition*, 74(5), 825–833. <https://doi.org/10.1038/s41430-019-0486-x> (Last accessed on August 21, 2025).
- Bhadada, S. K., Chadha, M., Sriram, U., Pal, R., Paul, T.V., Khadgawat, R., Joshi, A., Bansal, B., Kapoor, N., Aggarwal, A., Garg, M. K., Tandon, N., Gupta, S., Kotwal, N., Mahadevan, S., Mukhopadhyay, S., Mukherjee, S., Kukreja, S. C., Rao, S. D., & Mithal, A. (2021).** The Indian Society for Bone and Mineral Research (ISBMR) position statement for the diagnosis and treatment of osteoporosis in adults. <https://pubmed.ncbi.nlm.nih.gov/34176015/> (Last accessed on August 7, 2025).
- Calvo, M. S., Whiting, S. J., & Barton, C. N. (2004).** Vitamin D fortification in the United States and Canada: current status and data needs. *The American Journal of Clinical Nutrition*, 80(6 Suppl), 1710S–6S. <https://doi.org/10.1093/ajcn/80.6.1710S> (Last accessed on August 21, 2025).
- Dhaussy, A. (2014).** Vitamin D recommendations, fortification in France, and communication. *Oilseeds and fats, Crops and Lipids (OCL)*, 21(3), D305. <https://doi.org/10.1051/ocl/2013063> (Last accessed on August 21, 2025).
- Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B., & Chandon, P. (2021).** Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: Evidence from a large-scale randomized controlled trial. *Journal of the Academy of Marketing Science*, 49(1), 119–138. <https://doi.org/10.1007/s11747-020-00723-5> (Last accessed August 17, 2025).
- Food and Agriculture Organization of the United Nations (FAO) & World Health Organization (WHO). (1994).** Codex Alimentarius Commission Procedural Manual. <https://openknowledge.fao.org/server/api/core/bitstreams/78df753b-d1d8-43f3-84d2-20eb566695e1/content> (Last accessed August 17, 2025).
- ICMR-NIN Expert Committee (2024),** Dietary Guidelines for Indians – 2024. ICMR-National Institute of Nutrition, Hyderabad. (Last accessed on August 21, 2025).

- Lossifidis, S., Vaiou, M., Challa, A., Migdanis, A., Migdanis, I., Moula, A. I., Papageorgiou, M., Kokkinos, G., Deligiorgis, D., Varitimidis, S. E., Malizos, K. N., & Moulas, A. N. (2021).** Use of Fortified Bread for Addressing Vitamin D Deficiency. In P. Vlamos (Ed.), *GeNeDis 2020* (Vol. 1337, pp. 371–378). Springer International Publishing. https://doi.org/10.1007/978-3-030-78771-4_42 (Last accessed on August 21, 2025).
- Jääskeläinen, T., Itkonen, S. T., Lundqvist, A., Erkkola, M., Koskela, T., Lakkala, K., Dowling, K. G., Hull, G. L., Kröger, H., Karppinen, J., Kyllönen, E., Härkänen, T., Cashman, K. D., Männistö, S., & Lamberg-Allardt, C. (2017).** 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. *The American Journal of Clinical Nutrition*, 105(6), 1512–1520. <https://doi.org/10.3945/ajcn.116.151415> (Last accessed on August 21, 2025).
- Mukherjee, A., Chaudhry, A., Khatwani, L., Khanna, T., and Verma, P. (2025).** “Roadmap to Address Vitamin D Deficiency in India”, Academic Foundation and ICRIER, 2025. (Report) ISBN: 9789332706866. https://icrier.org/pdf/ES_Roadmap-to-Address-Vitamin-D_Deficiency.pdf (Last accessed on August 8, 2025).
- Nitish, A., Anand, P. K., Swarnkanta, L., Dhruvendra, P. (2024).** Vitamin D deficiency among pregnant women in India. *Bioinformation*, 31;20(12):2029-2033. doi: 10.6026/9732063002002029. PMID: 40230908; PMCID: PMC11993426. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11993426/> (Last accessed on August 8, 2025).
- Reddy, K. A. (2020).** Prevalence of rickets: a clinical study. *International Journal of Contemporary Pediatrics*, 7(3), 593. <https://doi.org/10.18203/2349-3291.ijcp20200684> (Last accessed on August 7, 2025).
- Tangpricha, V., Koutkia, P., Rieke, S. M., Chen, T. C., Perez, A. A., & Holick, M. F. (2003).** Fortification of orange juice with vitamin D: a novel approach for enhancing vitamin D nutritional health. *The American Journal of Clinical Nutrition*, 77(6), 1478–1483. <https://doi.org/10.1093/ajcn/77.6.1478> (Last accessed August 17, 2025)
- United Nations Children’s Fund (2023).** Large-scale Food Fortification for the Prevention of Micronutrient Deficiencies in Children, Women and Communities: Guidance Note. (Last accessed on August 8, 2025).
- Vatanparast, H., Calvo, M. S., Green, T. J., & Whiting, S. J. (2010).** Despite mandatory fortification of staple foods, Vitamin D intakes of Canadian children and adults are inadequate. *The Journal of Steroid Biochemistry and Molecular Biology*, 121(1-2), 301–303. <https://doi.org/10.1016/j.jsbmb.2010.03.079> (Last accessed August 17, 2025).

World Health Organization & Food and Agriculture Organization of the United Nations. (2006). Guidelines on food fortification with micronutrients. (Last accessed on August 14, 2025).

Zimmermann, M. B., Andersson, M., & Makhmudov, A. (2021). Global progress in iodized salt coverage and iodine nutrition. *The Lancet Diabetes & Endocrinology*, 9(6), 277–289. [https://doi.org/10.1016/S2213-8587\(21\)00077-3](https://doi.org/10.1016/S2213-8587(21)00077-3). (Last accessed on September 07, 2025).

Puri, S., Marwaha, R., Agarwal, N., Tandon, N., Agarwal, R., Grewal, K., Reddy, D. H. K., & Singh, S. (2007). Vitamin D status of apparently healthy schoolgirls from two different socioeconomic strata in Delhi: Relation to nutrition and lifestyle. *British Journal of Nutrition*, 99(4), 876–882. <https://doi.org/10.1017/S0007114507831758> (Last accessed on January 21, 2025).

Khadilkar A, Mandlik R. (2015). Epidemiology and treatment of osteoporosis in women: An Indian perspective. *International Journal of Women's Health*, 8, 841–850. <https://doi.org/10.2147/IJWH.S54623> (Last accessed on January 21, 2025).

Aparna P, Muthathal S, Nongkynrih B, Gupta SK. (2018). Vitamin D deficiency in India. *Journal of Family Medicine and Primary Care*. 2018 Mar-Apr;7(2):324–330. doi:10.4103/jfmpc.jfmpc_78_18. PMID: 30090772; PMCID: PMC6060930. (Last accessed on January 21, 2025).

Gupta, R., & Gupta, A. (2014). Fortification of foods with Vitamin D in India. *Nutrients*, 6(9), 3601–3623. <https://doi.org/10.3390/nu6093601> (Last accessed on January 21, 2025).



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At the heart of ANVKA's mission is the promotion of innovative education that integrates the socio-political, economic, spiritual and aesthetic dimensions. The foundation advocates the re-education of relationships, challenging patriarchal norms and fostering mutual respect and dignity to build a more equitable society. ANVKA works to dismantle oppressive social structures, focusing on creating a future grounded in love, understanding and equality. Additionally, the foundation promotes environmental sustainability and livelihoods that are ecologically responsible and socially fair, recognizing the interconnectedness of all life and striving for harmony between humans and the environment. Their efforts also include promoting active citizenship by encouraging individuals to engage in participatory democracy and take an active role in shaping their communities.

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