Opinion and Analysis

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Mandating Vitamin D Availability in Low- and Middle-Income Countries: Time to Act on A Silent Pandemic

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Abstract

Vitamin D deficiency impacts over 1 billion individuals globally and qualifies as a pandemic, yet it remains largely unrecognized by healthcare systems in low- and middle-income countries (LMICs). The combined prevalence of serum 25-hydroxyvitamin D levels below 50 nmol/L is 56% in LMICs, with even greater rates among pregnant women, adolescents, and the elderly. South Asia is significantly affected, with adult deficiency rates surpassing 65% in Pakistan, Bangladesh, and India. This Opinion and Analysis advocates for large-scale action to address vitamin D deficiency in LMICs, explores reasons for the ongoing deficiency in sunny regions, and discusses why universal biochemical testing is not the appropriate solution. Drawing on global and regional epidemiology, the Bill & Melinda Gates Foundation and the New York Academy of Sciences expert roadmap, country-level cost-effectiveness modelling, and the Finnish precedent of mandatory food fortification, we argue that three policy instruments used together can shift the population distribution of 25-hydroxyvitamin D within a few years: mandatory fortification of staple foods such as edible oil and milk; targeted supplementation of high-risk groups; and clear public-health communication on sensible sun exposure and dietary sources. This package is biologically sound, operationally feasible, and economically attractive. Cost-effectiveness analyses from India and the United Kingdom suggest that fortification is cost-saving at the population level. The case for ministries of health in Pakistan, India, Bangladesh, and other LMICs to make vitamin D mandatorily available through the foods their populations already eat is now stronger than the case for further delay.

Keywords: Vitamin D deficiency; food, fortified; public health; developing countries; dietary supplements

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Introduction

The Scale of a Silent Pandemic

Vitamin D deficiency now affects more than 1 billion people worldwide and meets every reasonable epidemiological criterion of a pandemic, despite remaining largely invisible to clinical services. A pooled meta-analysis of 7.9 million participants from 81 countries between 2000 and 2022 estimated that 47.9% of the global population had serum 25-hydroxyvitamin D [25(OH)D] below 50 nmol/L and 15.7% below 30 nmol/L, with the highest burden concentrated in lower-middle-income countries (LMICs) at 56.0% and 26.7%, respectively (1). Females, adolescents, and pregnant women carry a disproportionate share of this burden (1). South Asia is a striking example: a regional meta-analysis of adults reported pooled deficiency of 68%, with country-level estimates of 73% in Pakistan and 67% in India, 67% in Bangladesh (2). A recent national assessment from Bangladesh found that approximately 67% of the general population were deficient, with as many as 83% of adolescents and 78% of pregnant women below sufficiency thresholds (3). In India, community studies have consistently reported deficiency in 70% to 90% of apparently healthy individuals across age groups, geography, and socioeconomic strata (4, 5).

Why Deficiency Persists in Sun-Rich LMICs

It is paradoxical that countries straddling the tropics report some of the highest prevalence figures globally. Several converging factors explain this. First, melanin-rich skin requires considerably longer ultraviolet B exposure to synthesize comparable amounts of cholecalciferol (pro-vitamin D) than lighter skin (6). Second, urbanization, indoor occupations, school routines, atmospheric

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pollution, and the cultural use of full-body clothing have sharply curtailed effective sun exposure across the Indian subcontinent, the Middle East, and parts of Africa (1, 6). Third, dietary intake of vitamin D in LMICs is intrinsically poor: oily fish, egg yolk, and liver are infrequently consumed in sufficient quantities, and the staple foods that dominate household budgets, cereals, pulses, edible oil, and milk, are rarely fortified with vitamin D in most LMICs (4, 7). A global mapping exercise found that, although 36 countries fortify edible oils with vitamin A, only 10 currently mandate or permit fortification with vitamin D (7). The result is a population that lives in a high-ultraviolet environment yet receives almost no vitamin D from food and very little from skin synthesis.

The Diagnostic Dilemma: Why Testing Every Individual Is the Wrong Answer

A frequent clinical reflex is to demand serum 25(OH)D quantification before any intervention. In LMIC settings this is neither affordable nor strategically sensible. A single antibody-based 25(OH)D assay in India costs the patient approximately PKR 5,000 to 7,000 (around US$18 to US$25), and reference laboratories charge two to three times more for a comprehensive panel; this is unaffordable for most households whose monthly per-capita expenditure is comparable to or below the price of one test (4). In Pakistan, Bangladesh, Nepal, and much of sub-Saharan Africa, the assay is rarely available outside tertiary urban centres (3). More importantly, when the population prevalence of deficiency exceeds 50%, the positive predictive value of any test is so high that universal screening adds cost without altering management (4, 7). The Bill & Melinda Gates Foundation and the New York Academy of Sciences expert roadmap therefore recommend a population-based response, fortification and targeted supplementation, once national or sub-national prevalence of 25(OH)D below 30 nmol/L exceeds 20% or rickets prevalence exceeds 1%, both of which thresholds are routinely met in LMICs (7).

Consequences of Inaction

The skeletal consequences, nutritional rickets in infants, osteomalacia, and earlier-onset osteoporosis in adults, remain the most visible toll, and rickets continues to be reported in alarming numbers across South Asia, the Middle East, and sub-Saharan Africa (7, 8). The non-skeletal consequences, however, are increasingly difficult to dismiss. A landmark individual-participant-data meta-analysis of 25 randomized trials demonstrated that vitamin D supplementation produced a modest but statistically significant reduction in acute respiratory tract infections, with the largest absolute benefit in those who were most deficient at baseline (9). Maternal vitamin D deficiency is associated with pre-eclampsia, gestational diabetes, and low birth weight (7), and observational and Mendelian-randomization studies have linked low vitamin D to cardiovascular mortality, type 2 diabetes, several malignancies, autoimmune disease, and severe COVID-19 (1, 10). For health systems already struggling with the double burden of communicable and non-communicable disease, a population-wide micronutrient gap of this magnitude is a strategic liability.

What Can Be Done: A Feasible Policy Package

Three policy instruments, used together, can shift the population distribution of vitamin D within a few years. First, mandatory fortification of staple foods. Edible oil and milk are consumed almost universally in LMICs and are technically straightforward to fortify with cholecalciferol; oil already carries vitamin A in many of these countries, and adding vitamin D is incremental. The Indian Food Safety and Standards Authority standards already permit fortification, and Bangladesh is amending its mandatory edible-oil standard to include vitamin D alongside vitamin A (3, 11). Second, targeted supplementation. Pregnant and lactating women, exclusively breastfed infants, adolescents, and the institutionalized elderly should receive daily or weekly vitamin D as part of routine antenatal, child-health, and geriatric programs, analogous to existing iron-folate distribution (7). Third, public-health communication. Sensible sun exposure (10 to 30 minutes of arm and leg exposure between 10 a.m. and 3 p.m., several times weekly), affordable food sources, and the recognition of high-risk groups should be embedded in primary-care and school curricula (1, 7).

The Economic Case

The argument for government action rests on more than ethics. Modelled estimates from England and Wales suggested that universal food fortification with vitamin D would be cost-saving over a 90-year horizon, even using conservative assumptions about non-skeletal benefits (12). A recent Indian cost-effectiveness analysis estimated that fortifying edible oil at scale would cost roughly US$7.6 million annually and milk fortification a further US$9.8 million for vulnerable groups, while averting almost 100,000 years lived with disability attributable to vitamin D deficiency, a fraction of what equivalent supplementation programs or downstream treatment of rickets, osteoporotic fractures, and recurrent respiratory infections would cost (11). By contrast, the implicit cost of inaction includes hospital admissions for severe rickets, surgical correction of skeletal deformity, increased tuberculosis risk in deficient hosts, and fragility-fracture care in an ageing population, expenditures that fall hardest on the public sector (4, 8, 9).

A Success Story Worth Emulating

Finland offers a clear precedent. Since 2003, the country has mandatorily fortified fluid milk and fat spreads with vitamin D. Mean serum 25-hydroxyvitamin D concentrations rose by roughly 50% within a few years, and the prevalence of insufficiency in young men fell from 78% before fortification to approximately 35% afterwards, with gains sustained over more than a decade (13). The Finnish experience demonstrates that population status can be improved within a single decade through a simple regulatory change, without requiring new infrastructure or large recurring expenditure.

Conclusion and Directions for Future Research

The issue is not if vitamin D deficiency poses a public health challenge in LMICs, this is clear, but whether governments will address it. Enforcing mandatory fortification of key foods, alongside focused supplementation for the most at-risk, while

avoiding reliance on individual biochemical testing, is scientifically valid, practically attainable, and cost-effective. The alternative is to sustain an unnoticed crisis through avoidable hospital admissions and reduced productivity. For the health ministries in Pakistan, India, Bangladesh, and other low- and middle-income countries (LMICs), there is now support for mandatory fortification of foods with vitamin D, as the populations already consume these staple foods. Upcoming research should focus on implementation science and monitoring the distribution of 25(OH)D levels post-fortification, while also creating national cost-effectiveness models that encompass all health benefits related to bone and other health areas, facilitating policy development through the accumulation of evidence.

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Authors' Contribution:
MR: Conceived and drafted the manuscript and critically revised the final version

References

1. Cui A, Zhang T, Xiao P, Fan Z, Wang H, Zhuang Y. Global and regional prevalence of vitamin D deficiency in population-based studies from 2000 to 2022: a pooled analysis of 7.9 million participants. Front Nutr. 2023;10:1070808. doi: 10.3389/fnut.2023.1070808
2. Siddiqee MH, Bhattacharjee B, Siddiqi UR, Meshbahur Rahman M. High prevalence of vitamin D deficiency among the South Asian adults: a systematic review and meta-analysis. BMC Public Health. 2021;21:1823. doi: 10.1186/s12889-021-11888-1
3. Akhter Alo RZ, Mahfuz A, Chowdhury MAB. Widespread vitamin D deficiency: evidence of a major public health concern in Bangladesh. Geneva: Global Alliance for Improved Nutrition; 2026. Available from: https://www.gainhealth.org/blogs/widespread-vitamin-d-deficiency-evidence-major-public-health-concern-bangladesh
4. Aparna P, Muthathal S, Nongkynrih B, Gupta SK. Vitamin D deficiency in India. J Family Med Prim Care. 2018;7(2):324–30. doi: 10.4103/jfmpc.jfmpc_78_18
5. Pal B, Temba AC, Chaudhary V, Kumari S, Sharma B. Prevalence of vitamin D deficiency in apparently healthy Indian children and adolescents: a systematic review and meta-analysis. Nutr Clin Metab. 2025;39:154–63. doi: 10.1016/j.nupar.2025.06.001
6. Demay MB, Pittas AG, Bikle DD, Diab DL, Kiely ME, Lazaretti-Castro M, et al. Vitamin D for the prevention of disease: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2024;109(8):1907–47. doi: 10.1210/clinem/dgae290
7. Roth DE, Abrams SA, Aloia J, Bergeron G, Bourassa MW, Brown KH, et al. Global prevalence and disease burden of vitamin D deficiency: a roadmap for action in low- and middle-income countries. Ann N Y Acad Sci. 2018;1430(1):44–79. doi: 10.1111/nyas.13968
8. Munns CF, Shaw N, Kiely M, Specker BL, Thacher TD, Ozono K, et al. Global consensus recommendations on prevention and management of nutritional rickets. J Clin Endocrinol Metab. 2016;101(2):394–415. doi: 10.1210/jc.2015-2175
9. Martineau AR, Jolliffe DA, Hooper RL, Greenberg L, Aloia JF, Bergman P, et al. Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data. BMJ. 2017;356:i6583. doi: 10.1136/bmj.i6583
10. Pereira M, Dantas Damascena A, Galvão Azevedo LM, de Almeida Oliveira T, da Mota Santana J. Vitamin D deficiency aggravates COVID-19: systematic review and meta-analysis. Crit Rev Food Sci Nutr. 2022;62(5):1308–16. doi: 10.1080/10408398.2020.1841090
11. Kumar A, Ahluwalia K, Edathil AP, Sankar R, Arlappa N, Nair S, et al. Cost-effectiveness of oil and milk fortification by scale for reducing vitamin A and vitamin D deficiency in India. PLoS One. 2025;20:e0331790. doi: 10.1371/journal.pone.0331790
12. Aguiar M, Andronis L, Pallan M, Högler W, Frew E. The economic case for prevention of population vitamin D deficiency: a modelling study using data from England and Wales. Eur J Clin Nutr. 2020;74(5):825–33. doi: 10.1038/s41430-019-0486-x
13. Raulio S, Erlund I, Männistö S, Sarlio-Lähteenkorva S, Sundvall J, Tapanainen H, et al. Successful nutrition policy: improvement of vitamin D intake and status in Finnish adults over the last decade. Eur J Public Health. 2017;27(2):268–73. doi: 10.1093/eurpub/ckw154
14. Laaksi IT, Ruohola JP, Ylikomi TJ, Auvinen A, Haataja RI, Pihlajamäki HK, et al. Vitamin D fortification as public health policy: significant improvement in vitamin D status in young Finnish men. Eur J Clin Nutr. 2006;60(8):1035–38. doi: 10.1038/sj.ejcn.1602414