FOOD FORTIFICATION:
Policy Recommendations to Strengthen Programmes and Enhance Impact

December 2024

KEY MESSAGES

- Micronutrient deficiencies are widespread globally; recent studies revealed that 1 in 2 children and 2 in 3 women are deficient in at least one micronutrient.
- Fortifying staple foods with micronutrients is a cost-effective and safe intervention that is proven to prevent micronutrient deficiencies and related outcomes.
- While food fortification programmes are widely implemented around the world, gaps remain. The availability and coverage of high-quality fortified foods are often low, even in countries with fortification mandates, and many countries that could benefit from fortification programmes do not have them.
- Countries need support to implement best practices around appropriate programme design, effective monitoring of quality and compliance, and regular review of programme assumptions to ensure they remain safe and impactful over time.
- National governments, industry, technical partners, and donors all have diverse roles to play in strengthening food fortification programmes and enhancing impact.

THE PROBLEM: WIDESPREAD MICRONUTRIENT DEFICIENCIES

Globally, it is estimated that half of all preschool-aged children and two-thirds of all non-pregnant women of reproductive age are deficient in at least one micronutrient (i.e., vitamin or mineral) (1). Approximately 75% of children with micronutrient deficiencies live in south Asia, sub-Saharan Africa, and east Asia and the Pacific (**Figure 1**). Sub-Saharan Africa has the highest prevalence of micronutrient deficiency of any region globally, with an estimated 98 million school-aged children and 161 million non-pregnant women of reproductive age suffering from at least one micronutrient deficiency.

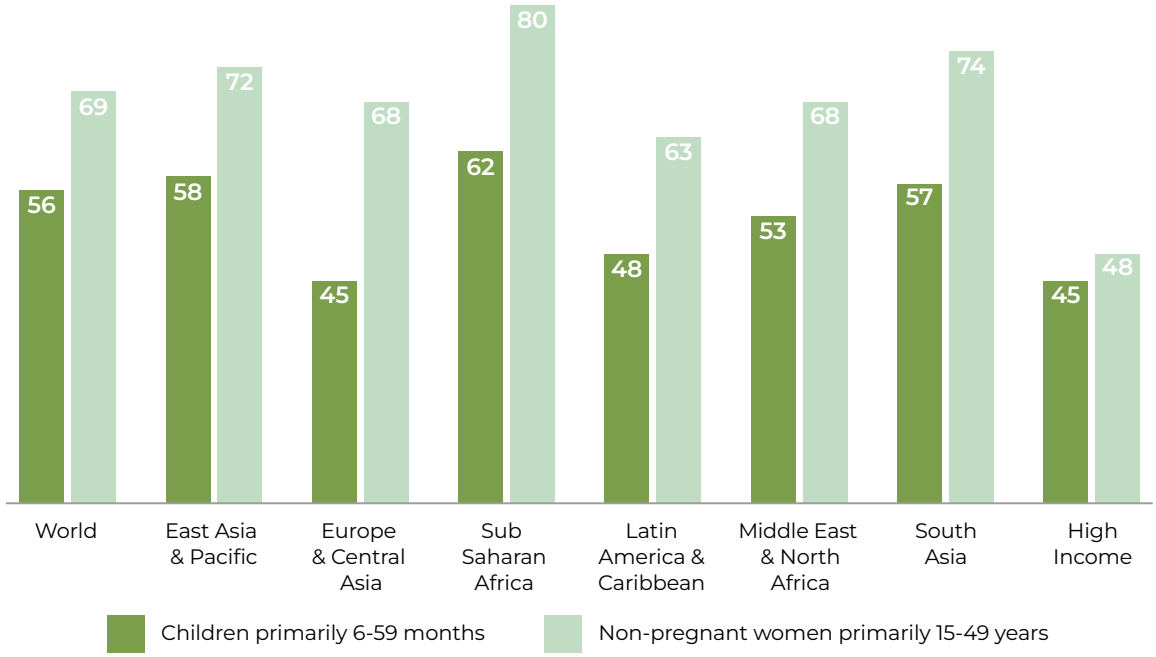

Figure 1: Percentage of children 6-59 months and non-pregnant women primarily 15-49 years with deficiencies in one or more of three micronutrients (i.e., among zinc, vitamin A and/or iron in children and folate, zinc and/or iron in women) (Source (1))

Micronutrient deficiencies can have severe consequences, such as reduced growth, increased risk of infections, birth defects, blindness, cognitive impairment, and even death (2,3). At the same time, the health challenges associated with malnutrition have economic consequences. Productivity losses and slower economic growth resulting from the effects of malnutrition on people's physical and cognitive abilities can reduce a country's gross domestic product by between 3% and 16%. Globally, this costs at least one trillion dollars each year (4).

Young children and women of reproductive age are often considered the most vulnerable to micronutrient deficiencies due to their greater needs at these life stages. However, the actual risk in other population groups, such as adolescents, men, and the elderly, is largely unknown due in part to the lack of data available on the prevalence of micronutrient deficiencies in these populations. As a proxy for micronutrient status, a recent global modelling study estimated the prevalence of inadequate micronutrient intakes of 15 micronutrients for 34 age-sex groups in 185 countries based on dietary intake data (excluding supplementation and fortification) (5). The study found that over 5 billion people do not consume enough iodine, vitamin E, and calcium and over 4 billion do not consume enough iron, riboflavin, folate, and vitamin C.

Together, these findings suggest that micronutrient deficiencies are likely to affect all countries and population groups around the world.

THE SOLUTION: IMPROVE MICRONUTRIENT INTAKES THROUGH FORTIFIED STAPLE FOODS

Improving micronutrient intakes is the ultimate solution to addressing micronutrient deficiencies. This can be accomplished through several complementary interventions, including dietary diversification, supplementation, and food fortification. Here, we focus on the latter.

Large-scale food fortification (LSFF) (also known as industrial or mass food fortification) is the addition of micronutrients at the point of processing to commonly consumed foods and condiments, such as wheat flour, maize flour, oil, salt, rice, and milk, among others. Because LSFF targets staple foods that are already regularly consumed by large segments of the population, it requires little to no behaviour change by consumers.

Scale and Delivery

As of October 2024, over 143 countries worldwide mandate fortification of at least one staple food (**Figure 2**) (6). In Africa for example, mandatory fortification exists in 30 countries for wheat flour, 25 countries for edible oil, 45 countries for salt, and 12 countries for maize flour.

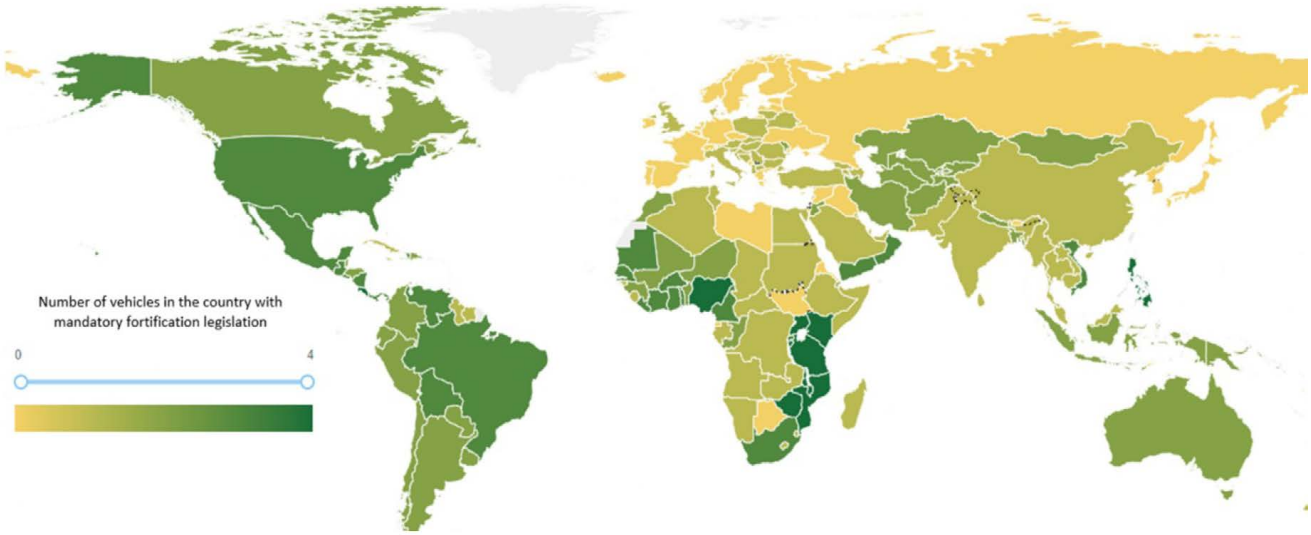

Figure 2: Countries and number of staple foods with mandatory fortification programmes for select foods (i.e., wheat flour [n=92], maize flour [n=19], oil [n=35], salt [n=126], and rice[n=8]) (Source: (6)).

Delivery Channels

LSFF of widely consumed staple foods is mainly delivered through open markets, where it can reach large segments of the population. It is important to ensure equitable access to fortified foods so that vulnerable groups (e.g., low-income families, women, and children) are reached. As such, there have been increasing efforts to integrate fortified foods into social assistance, protection, and other programmes within food systems delivery channels. These include, but are not limited, to public distribution, food voucher, food basket distribution, and school feeding programmes. Examples of countries that include fortified foods in public distribution programmes are India (7), Cambodia (8), Bangladesh (9), and Mexico (10).

School feeding programmes are an important channel to provide children with micronutrient-dense meals, and studies demonstrate a positive effect on micronutrient status of school-aged children as a result (11). Globally, an estimated 117 countries have school feeding programmes in place (12), and organizations like the World Food Programme (WFP) are working in more than 40 countries to integrate fortified foods into these school feeding and other food assistance programmes (13). Approximately 60% of WFP-distributed foods (roughly 3 billion rations or enough for 17 million people) are sourced from fortified staples such as rice, wheat flour, maize flour or edible oil with a goal to increase this to 80% by 2025 (13).

Impact

There is a large body of evidence that mandatory LSFF reduces micronutrient deficiencies and improves health outcomes in diverse population groups when high-quality fortified foods are available and consumed. In low- and middle-income countries, LSFF has been found to reduce anaemia by 34% due to improved iron stores, decrease the odds of goitre by 74% due to reductions in iodine deficiency, decrease the odds of neural tube defects by 41% due to reductions in folate deficiency among women of reproductive age. and reduce the prevalence of vitamin A deficiency for 3 million children aged 0-9 in just one year, significantly reducing their risk of mortality (14). The biggest success story to date has been the fortification of salt with iodine. It is estimated that globally 89% of households consume iodised salt (15), with over 720 million cases of goitre prevented (16).

A review of health impact studies from low- and middle-income countries (e.g., Uganda, Cambodia, Vietnam, Ghana, Lao PDR, and India, among others) found that school feeding programmes that provided fortified foods drove improvements in micronutrient status of school aged children (17). For example, in India, such programmes improved levels of vitamin A, folate, and iron (18). In Cambodia, the inclusion of rice fortified with micronutrients reduced zinc, folic acid, and vitamin A deficiencies, improved cognitive performance, and reduced iron-deficiency anaemia at low cost (8).

Cost-effectiveness

LSFF is one of the most cost-effective interventions to address micronutrient deficiencies (19). Depending on the selected staple food being fortified, LSFF can cost between just 5 and 15 cents per person per year, and the benefit-to-cost ratios are high. Salt iodization has a benefit-to-cost ratio of 30:1, while wheat flour and maize flour fortification with folic acid and iron, respectively have benefit-to-cost ratios of 46:1 and 8:1. For every one dollar invested in fortification, there is an overall economic return of 27 US dollars on average, which accrue through averted disease, improved earnings, and enhanced work productivity (20).

Safety

When food fortification programmes are designed and implemented in accordance with global guidelines, they are proven to be a safe way of increasing intakes of essential micronutrients (21).

Safety is an important consideration when determining the type and amounts of micronutrients to add to the selected foods. During the design stage of a LSFF programme, fortification standards should be set to ensure that fortified foods are safe to consume by all. To determine this, predicted micronutrient intakes among diverse population groups (specifically for those at the highest levels of fortification and consumption) are assessed and compared to the upper limit of the micronutrient permitted by dietary guidelines (i.e., the highest level of intake that does not negatively impact any group). Then, during implementation of a LSFF programme, effective quality control and monitoring systems must be in place to ensure that fortified foods available for consumption meet the defined fortification standards.

REMAINING GAPS

Despite the proven effectiveness of LSFF, gaps in fortification mandates and poor quality and coverage of fortified foods in countries with existing programmes mean that many countries are not achieving the full benefits.

Mandates

At least 84 countries lack current fortification programmes but could benefit from the fortification of staple foods with iodine, folic acid, iron, and/or vitamin A based on their micronutrient needs and consumption patterns of foods that could be fortified (22).

Other countries with existing food fortification programmes may need to review and/or update their fortification standards to align with global guidance, current consumption patterns, and account for micronutrient intakes from other overlapping micronutrient deficiency prevention programmes. These steps are critical to ensure that the contribution of fortified foods to people's micronutrient intakes remain appropriate and safe.

Several countries with voluntary food fortification programmes could also benefit from mandates (22). This is because voluntary programmes do not typically address micronutrient deficiencies at scale. To achieve population-level reductions in diseases, such as iron deficiency anaemia, and birth defects, such as spina bifida and hydrocephalus, food fortification must be mandatory. Mandatory fortification has the additional benefit of levelling the playing field for producers, so that businesses producing fortified foods are not forced to compete with less nutritious, but slightly cheaper versions of the same products.

Quality, Coverage, and Monitoring

While many countries have LSFF programmes, there is a lack of information on the quality and coverage of available fortified foods. What does exist, reveals that foods are often under-fortified or not fortified at all (23). Household-level data on coverage and contribution to micronutrient intakes reveal similar results in terms of low-quality of fortified foods and thus limited contribution to micronutrient intakes (for example (22,24,25)). Such challenges tend to arise due to low willingness and/or capacity of industry to fortify and of government to monitor and enforce. Fortification inputs and infrastructure are added costs for producers (e.g., procurement of equipment, premix, and micronutrients). As are the added steps to ensure consistent quality assurance/ quality control (QA/QC) are in place that enable their inputs, production processes, and end products to meet the respective product specifications for both micronutrient premix producers and food producers/ processors. Where gaps exist, efforts to provide technical assistance, build capacity, reduce economic barriers, and improve local access to high-quality premix are critical.

Governments play a key role in ensuring that fortification programmes are monitored, and regulations are effectively incentivized and enforced. However, establishing and maintaining consistent monitoring mechanisms can be time- and resource-intensive. Streamlining efforts to monitor compliance and quality is critical. In a well-functioning monitoring and enforcement system, government agencies are empowered, responsible, and accountable for monitoring. A robust governance system and mechanisms to ensure sustained data collection to monitor the fortification programme over time are critical.

BEST PRACTICES TO ENSURE EFFECTIVE FOOD FORTIFICATION

Following best practices can help to fill the gaps described above to ensure fortification programmes are effective and have high potential for impact. These include:

- **Appropriate programme design**, meaning that: a) the food selected is available and regularly consumed in a fortifiable form (i.e., processed industrially and thus amenable to fortification by the food producer); and b) the type and amounts of micronutrients to be added are based on the degree and distribution of micronutrient deficiency as well as the consumption patterns in the population.
    - Fortification should be mandatory for all large-scale producers of the selected food to effectively address a micronutrient deficiency that is prevalent across the population.
- **Effective quality control and monitoring systems**, to ensure availability of high-quality fortified foods in the market and other distribution channels that meet fortification standards.
    - *For micronutrient premix producers and food producers/processors:* this requires conducting consistent QA/QC practices to ensure inputs, production processes, and end products meet the specifications (as per the national fortification standard).
    - *For regulatory and monitoring authorities:* this requires a) conducting regulatory monitoring at different points of the supply chain[1], to ensure that available food products in the country (both imported and domestically produced) meet national fortification standards and b) reviewing and using quality control and monitoring data to track programme progress and identify areas for improvement.
        - ❏ To support these activities, there are several guidance documents available. For example, detailed global and regional monitoring manuals have been developed for specific staple foods, such as wheat flour, salt, and oil (26–28) and generally for fortified foods (29).
- **Regular review of the assumptions related to the programmes design**, such as consumption patterns and the prevalence of micronutrient deficiencies (as well as other overlapping micronutrient deficiency prevention programmes) in the population to ensure the programme remains appropriate and safe.

RECOMMENDATIONS

- The international community needs to support countries to implement best practices around programme design, monitoring quality and compliance, measuring impact, and reviewing programme assumptions. This is the case for both new and existing programmes.
- National governments should ensure that when fortification mandates are passed, they are upheld, standards are set, programmes are monitored, and regulations are incentivised and enforced.
    - Ensuring adequate fortification standards exist and enabling industry to comply with them can be supported through building government and industry capacity.
    - Improving monitoring and evaluation of fortification programmes can be achieved through supporting and equipping national agencies and relevant stakeholders to monitor and enforce programmes consistently and efficiently through clear protocols for these activities.

1 I.e., inspections of the local production sites and verification of product specifications and/or product sample analysis at import or retail/market levels.

- Industry (e.g., micronutrient/premix producers and fortified food producers/processors) must produce high-quality inputs and fortified foods in accordance with national fortification standards.
- Technical partners can provide advocacy and technical support to countries to pass mandates, ensure adequate standards are set, monitor quality and compliance, measure the impact of fortification programmes as well as support the translation of evidence into programme improvement recommendations.
- Donors can increase commitment and funding to new and existing fortification programmes.

- All stakeholders should increase engagement in global and regional efforts and partnerships to ensure consistency in food fortification implementation and compliance and reduce trade barriers.

CONCLUSION

Large-scale food fortification is a proven, cost-effective, and safe intervention to reduce micronutrient deficiencies that is used widely across the world. While gaps remain that hinder the ability of fortification programmes to reach their full potential, there are known best practices and available guidelines to help ensure effective design and delivery of food fortification programmes. Food fortification stakeholders, including national governments, industry, technical partners, and donors, play diverse and important roles in supporting and strengthening food fortification programmes and enhancing their impact on populations.

REFERENCES

1. Stevens GA, Beal T, Mbuya MNN, Luo H, Neufeld LM, Addo OY, et al. Micronutrient deficiencies among preschool-aged children and women of reproductive age worldwide: a pooled analysis of individual-level data from population-representative surveys. The Lancet Global Health. 2022 Nov;10(11):e1590–9.
2. Bailey RL, Jr KPW, Black RE. The Epidemiology of Global Micronutrient Deficiencies. ANM. 2015;66(Suppl. 2):22–33.
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet. 2013 Aug;382(9890):427–51.
4. Food and Agriculture Organization of the United Nations (FAO). The State of Food and Agriculture 2013: Food Systems for Better Nutrition [Internet]. Rome: FAO; 2013 [cited 2024 Oct 17]. Available from: https://www.fao.org/4/i3300e/i3300e00.htm
5. Passarelli S, Free CM, Shepon A, Beal T, Batis C, Golden CD. Global estimation of dietary micronutrient inadequacies: a modelling analysis. The Lancet Global Health [Internet]. 2024 Aug 29 [cited 2024 Aug 30]; Available from: https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(24)00276-6/fulltext
6. Global Fortification Data Exchange. Map: Fortification Legislation [Internet]. 2024 [cited 2024 Oct 14]. Available from: https://fortificationdata.org/
7. Ministry of Consumer Affairs, Food & Public Distribution. Press Information Bureau, Government of India. 2024 [cited 2024 Oct 25]. Nutritious Boost: Free Fortified Rice for a Healthier India. Available from: http://pib.gov.in/PressNoteDetails.aspx?NoteId=153272
8. World Food Programme, Virginia Tech University. Economic Impact of Using Fortified Rice in Cambodia's School Feeding Programme [Internet]. Phnom Penh, Cambodi; 2023 [cited 2024 Nov 7]. Available from: https://socialprotection.org/discover/publications/economic-impact-using-fortified-rice-cambodia%E2%80%99s-school-feeding-programme
9. Nutrition International. Bangladesh Programs [Internet]. Ottawa, Canada: Nutrition International; 2019. Available from: https://www.nutritionintl.org/wp-content/uploads/2019/11/Bangladesh-Country-Brief.pdf
10. Neufeld LM, García-Guerra A, Quezada AD, Théodore F, Bonvecchio Arenas A, Islas CD, et al. A Fortified Food Can Be Replaced by Micronutrient Supplements for Distribution in a Mexican Social Protection Program Based on Results of a Cluster-Randomized Trial and Costing Analysis. The Journal of Nutrition. 2019 Dec 1;149:2302S-2309S.

11. Olney DK, Gelli A, Kumar N, Alderman H, Go A, Raza A, et al. Nutrition-sensitive social protection programs within food systems [Internet]. Washington, DC: Food and Agriculture Organization of the United Nations and International Food Policy Research Institute; 2021 Sep [cited 2024 Nov 15]. (IFPRI Discussion Paper 02044). Available from: https://hdl.handle.net/10568/143464

12. Cupertino A, Ginani V, Cupertino AP, Botelho RBA. School Feeding Programs: What Happens Globally? International Journal of Environmental Research and Public Health. 2022 Jan;19(4):2265.

13. World Food Programme. World Food Programme: Saving Lives, Changing Lives. 2024 [cited 2024 Nov 7]. Food fortification. Available from: https://www.wfp.org/food-fortification

14. Keats EC, Neufeld LM, Garrett GS, Mbuya MNN, Bhutta ZA. Improved micronutrient status and health outcomes in low- and middle-income countries following large-scale fortification: evidence from a systematic review and meta-analysis. Am J Clin Nutr. 2019;109(6):1696–708.

15. UNICEF Data: Monitoring the situation of children and women [Internet]. 2023 [cited 2024 Oct 25]. Iodine. Available from: https://data.unicef.org/topic/nutrition/iodine/

16. Gorstein JL, Bagriansky J, Pearce EN, Kupka R, Zimmermann MB. Estimating the Health and Economic Benefits of Universal Salt Iodization Programs to Correct Iodine Deficiency Disorders. Thyroid. 2020 Dec;30(12):1802–9.

17. World Food Programme. School feeding programmes in low- and lower-middle-income countries: A focused review of recent evidence from impact evaluations [Internet]. Rome, Italy: World Food Programme; 2021 Apr [cited 2024 Nov 7]. Available from: https://www.wfp.org/publications/school-feeding-programmes-low-and-lower-middle-income-countries

18. Osei AK, Rosenberg IH, Houser RF, Bulusu S, Mathews M, Hamer DH. Community-Level Micronutrient Fortification of School Lunch Meals Improved Vitamin A, Folate, and Iron Status of Schoolchildren in Himalayan Villages of India, ,. The Journal of Nutrition. 2010 Jun 1;140(6):1146–54.

19. Hoddinott J, Rosegrant M, Torero M. Investments to reduce hunger and undernutrition [Internet]. Washington, DC: International Food Policy Research Institute; 2012 Mar [cited 2024 Oct 25]. (Paper prepared for 2012 Global Copenhagen Consensus). Available from: https://copenhagenconsensus.com/sites/default/files/hungerandmalnutrition.pdf

20. Garrett G, Matthias D, Keats E, Mbuya M, Wouabe E. Bill & Melinda Gates Foundation. 2019 [cited 2024 Oct 25]. Doubling down on food fortification to fortify the future. Available from: https://www.gatesfoundation.org/ideas/articles/food-fortification-to-fortify-the-future

21. World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO). Guidelines on food fortification with micronutrients [Internet]. Allen L, de Benoist B, Dary O, Hurrell R, editors. World Health Organization and Food and Agriculture Organization of the United Nations; 2006 [cited 2023 Sep 21]. Available from: https://www.who.int/publications-detail-redirect/9241594012

22. Mkambula P, Mbuya MNN, Rowe LA, Sablah M, Friesen VM, Chadha M, et al. The Unfinished Agenda for Food Fortification in Low- and Middle-Income Countries: Quantifying Progress, Gaps and Potential Opportunities. Nutrients. 2020;12(2):354.

23. Luthringer CL, Rowe LA, Vossenaar M, Garrett GS. Regulatory Monitoring of Fortified Foods: Identifying Barriers and Good Practices. Glob Health Sci Pract. 2015 Sep 2;3(3):446–61.

24. Aaron, GJ, Friesen, VM, Jungjohann, S, Garrett, GS, Neufeld, LM, Myatt, M. Coverage of large-scale food fortification of edible oil, wheat and maize flours varies greatly by vehicle and country but is consistently lower among the most vulnerable: results from coverage surveys in eight countries. Journal of Nutrition. 2017;147(5):984S-94S.

25. Friesen VM, Mbuya MN, Aaron GJ, Pachón H, Adegoke O, Noor RA, et al. Fortified Foods Are Major Contributors to Apparent Intakes of Vitamin A and Iodine, but Not Iron, in Diets of Women of Reproductive Age in 4 African Countries. The Journal of Nutrition. 2020 Aug 1;150(8):2183–90.

26. ICCIDD. Salt Iodization Internal and External Quality Assurance and Quality Control Manual [Internet]. 2012 [cited 2016 Oct 1]. Available from: http://www.gainhealth.org/wp-content/uploads/2016/10/QA_QC-Manuals-and-Guideline-2012.pdf

27. ECSA Health Community Secretariat. Manual for External Monitoring of Oil Fortified with Vitamin A [Internet]. 2007 [cited 2016 Oct 1]. Available from: http://www.a2zproject.org/pdf/Manual%20for%20External%20Monitoring%20of%20Oil%20Fortified%20with%20Vitamin%20A.pdf

28. World Health Organization. Monitoring flour fortification to maximize health benefits: a manual for millers, regulators, and programme managers [Internet]. Geneva: World Health Organization; 2021 [cited 2021 Sep 27]. Available from: https://www.who.int/publications/i/item/978940032545

29. East, Central, and Southern Africa Health Community. Manual for inspection of fortified foods at the points of entry and market surveillance in the East, Central, and Southern Africa (ECSA) region: Second Edition [Internet]. 2020. Available from: https://ecsahc.org/wp-content/uploads/2021/11/ECSA-Manual-for-Inspection-of-Fortified-Foods-at-the-POEs-and-Markets.pdf

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