Food fortification programs and zinc deficiency

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The complex realities of most countries grappling with zinc deficiency pose challenges to the implementation of highly compliant, mandatory, large-scale food fortification programs.

Globally, zinc deficiency is estimated to affect 15% of the global population and considered to be a public health problem when the prevalence of inadequate intakes exceeds 25%[1]. Low- and middle-income countries (LMICs) are at most risk of dietary deficiency due to the consumption of predominantly plant-based diet, which have lower zinc content than diets that include meat and fish, and are high in phytic acid, a plant-based inhibitor of zinc absorption. In these countries, the prevalence of zinc deficiency may be as high as 80% in women and young children, based on plasma zinc concentration reported in national surveys, disproportionately affecting the poorest and most vulnerable communities whose access to high quality, nutrient dense foods is limited[2].

At the individual level, zinc deficiency may result in stunted growth and cognitive development in childhood, impaired immune function in adults and increased risk of complications during pregnancy for women. On a regional level, there is an economic cost through a reduction in Gross National Production[3]. Improving zinc intake of a population is challenging, because the intervention must be operationalised at scale and must reach the most vulnerable, often geographically hard to reach communities. Fortification of staple foods, through the addition of one or more key nutrients during food processing is one strategy to achieve this and has been highly successful in the case of iodised salt in reducing the global burden of iodine deficiency disease[4].

Writing in Nature Food, Wessells and colleagues[5] suggest that improving and optimising existing large scale food fortification (LSFF) programs has the potential to reduce the global burden of zinc deficiency by up to 50%. Specifically, the authors are referring to the post-harvest addition of zinc to an industrially processed food, in contrast to other methods of zinc fortification. Micronutrient powders can be added to foods prepared at home (home fortification), while biofortification is used to enhance the zinc content of crops through crop breeding and /or addition of zinc fertilizer during the growing cycle. For LSFF to be successful, it must have both reach and scale[6]. This means that the fortified food must be accessible to the whole population and affordable to the poorest. Also, that fortification process must be effectively implementable at scale, which includes comprehensive and continuous monitoring and quality assurance to ensure that the micronutrient content consistently aligns with the agreed program target level for effectiveness in the context of the national diet. For these reasons, low-cost dietary staples, such as cereal grains (wheat flour, maize flour, rice) are frequently chosen as the food vehicles for zinc and iron and folate fortification[2].

One of the main challenges to the operationalisation of LSFF is the effective monitoring and quality assurance. This requires a level of infrastructure and high-level co-ordination to ensure that standards are adhered to by the food processing industries. This is achievable where the food processing occurs in a limited number of centralised plants which are responsible for the majority of the national supply of that staple product. There are situations where this is not the case. For example, in Pakistan, only 40-60% of the flour consumed by the population is procured from industrial mills; the remaining proportion of household flour comes either from self-grown grain or

acquired directly from the farmer as payment[7]. In scenarios such as this, the reach and scalability of the program will inevitably be limited.

Wessells and colleagues[5] modelled the potential impact of optimising and improving existing LSFF programs on the prevalence of zinc deficiency, as well as the impact of introducing zinc into the established LSFF program in countries where it was not there already. As a baseline for comparison, the prevalence of inadequate zinc intake without any form of LSFF was estimated using national food balance sheets.

The modelling process revealed some important findings regarding the implementation and impact of current national LSFF standards. Wessells and colleagues[5] identified 40 countries where zinc deficiency was a public health problem. In countries where zinc fortification is mandatory (n=17), the estimated or reported median compliance rate for post-harvest zinc addition by food processing industries with national LSFF standards was only 65%. The low compliance rate, coupled with target zinc fortification levels that fall short of international guidelines, meant that even mandatory programs were predicted to fail to reduce the national prevalence of zinc deficiency to > 25% in some instances. If the compliance of food processing industries with national LSFF standards could be improved to 100% in countries where zinc fortification was mandatory, then only 2 of the 17 countries would still have a prevalence of zinc deficiency to >25%. However, even in this full compliance scenario, an estimated 698 million individuals across these 40 countries were still predicted be at risk of inadequate zinc intake, constituting a modest reduction in overall prevalence of zinc deficiency by 0.5%.

Modelling the best-case scenario, which introduces 100% compliance with a mandatory LSFF, set at new, updated international levels across all 40 countries predicting a reduction in the prevalence of zinc deficiency of 78% in these 40 countries, consequently reducing the global prevalence by 50%. This would indeed be an impressive outcome. However, lessons learned from countries such as Pakistan would suggest that the reality is complex and that context specific cultural, political, economic and behavioural factors can significantly impact the success or failure of a fortification initiative and must be fully understood and incorporated into the modelling and decision-making processes[6]. Thus, setting up or revising the existing standards to updated recommendations with near full compliance will still need strengthening mandatory fortification programs by promoting stakeholder collaboration, investing in infrastructure and capacity building, addressing socioeconomic factors, improving consumer awareness, and prioritizing monitoring and evaluation efforts.

Against the backdrop of climate change and disruptions in the global agri-food systems, and concerns about the impact of rising CO_2 levels on the micronutrient density of crops, the global challenge of zinc deficiency is only going to intensify. Finding a sustainable context-appropriate solution will require a range of strategies with food fortification playing a central role alongside biofortification and dietary diversification; however, addressing food insecurity and economic inequalities which underpin hidden hunger must be a universal priority[8].

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Competing interest
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Figure 1 Caption
Wheat grain during processing at flour mill in Khyber Pakhtunkhwa Province, Pakistan. Image taken by Bilawal Arbab as part of BiZiFED2 project.