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The critical role of food fortification in combatting malnutrition and disease susceptibility in Africa

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Malnutrition can severely compromise immune function, rendering populations more vulnerable to both communicable and non-communicable diseases. Here, we discuss food fortification and micronutrient supplementation programs that have been instrumental in mitigating malnutrition across Africa and in controlling disease spread, marking considerable advances in public health throughout the continent.

Malnutrition remains one of the most critical public health challenges across the African continent[1,2]. It affects ~200 million people, and more than one-third of children under five years of age are stunted, leading to long-term physical and cognitive impairments[3]. Malnutrition is estimated to cause around 2.9 million deaths annually in Africa, accounting for over a quarter of mortality on the continent[4]. In addition to the immediate health burden, malnutrition impedes economic development, hinders educational attainment, and weakens workforce productivity[5].

The burden of communicable diseases such as HIV/AIDS, malaria, cholera, and tuberculosis, as well as non-communicable diseases such as cardiovascular disease and cancer, is also disproportionately high in many African regions[6–10]. Malnutrition increases vulnerability to infectious diseases by impairing immune function, intensifying disease severity, and delaying recovery. In turn, repeated or chronic infections can further exacerbate malnutrition by reducing dietary intake, impairing nutrient absorption, and increasing metabolic demands. This bidirectional relationship creates a vicious cycle that is particularly detrimental in low-resource settings. In contrast, the link between malnutrition and non-communicable diseases (NCDs) is more complex and emerges over a longer time horizon. Early-life malnutrition—such as stunting, intrauterine growth restriction, or chronic deficiencies in key micronutrients—can predispose individuals to a higher risk of NCDs later in life. This increased susceptibility is thought to result from disruptions in metabolic programming, epigenetic modifications, and interactions with adverse postnatal environments[11]. As we discuss in this Comment, breaking this cycle of malnutrition and illness is vital for advancing the continent's socio-economic progress and improving overall quality of life.

Given these challenges, there is a growing emphasis on large-scale interventions to tackle malnutrition and micronutrient deficiencies. Food fortification, which is the addition of vitamins and minerals to staple foods, has emerged as a proven, cost-effective strategy to address nutrient shortfalls[12]. For example, folic acid fortification has led to substantial reductions in neural tube defects, while iodine fortification has significantly reduced goiter in many high-income countries[13]. This approach has significantly reduced disease incidence and mortality rates in high-income settings, but widespread implementation in sub-Saharan Africa (SSA) has encountered socioeconomic, infrastructural, and ethical barriers, including concerns about informed consumer consent, equitable access, and respect for cultural food preferences[14]. Nonetheless, new partnerships and technological innovations offer promising avenues for strengthening and scaling these initiatives.

Current landscape of malnutrition and disease in Africa

In 2022, malnutrition, particularly stunting and micronutrient deficiencies, was most prevalent in Central and Eastern Africa. Central Africa reported an overall malnutrition prevalence of 29.1%, with severe food insecurity affecting 39.1% of the population and moderate or severe food insecurity reaching 78.4%[15]. This region also exhibited the highest stunting prevalence (as shown in Fig. 1a) at 37.4%, with countries such as the Democratic Republic of the Congo (DRC), Republic of the Congo (RC), Central African Republic (CAR), and Chad particularly affected. In Eastern Africa, the overall malnutrition prevalence was 28.5%, where[15,16] Somalia is the most severely affected[17].

There is a notable overlap between malnutrition trends and the prevalence of several diseases in these regions. In Central Africa, high rates of malnutrition coincide with a heavy burden of infectious diseases. For instance, the DRC ranks among the highest for malaria prevalence[18] (Fig. 1b), and both the DRC and the CAR have experienced significant outbreaks of Mpox[19] (Fig. 1c), previously known as monkeypox. These observations underscore the dual challenge faced by these regions, where poor nutritional status often aligns with elevated disease incidence.

The evidence suggests a strong correlation between malnutrition and the heightened prevalence of certain diseases. Although this relationship is robust, it does not imply direct causation. Nigeria, for example, records the highest malaria prevalence even though malnutrition levels are not disproportionately high[18]. Other factors, such as poor sanitation, inadequate healthcare infrastructure, and challenging environmental conditions, also contribute significantly to disease dynamics. This point is underscored by recent communications from the Bill & Melinda Gates Foundation, which emphasize childhood malnutrition as a critical barrier to health equity and human development[20,21].

Food fortification implementation in Africa

Food fortification involves incorporating essential vitamins and minerals, such as iron, iodine, vitamin A, and folic acid, into commonly consumed staple items ranging from flours to cooking oils. This approach has long been recognized as safe and economical in high-income countries, reducing deficiencies and associated diseases. In Africa, large-scale food fortification (LSFF) programs have already demonstrated promising results[14]. For

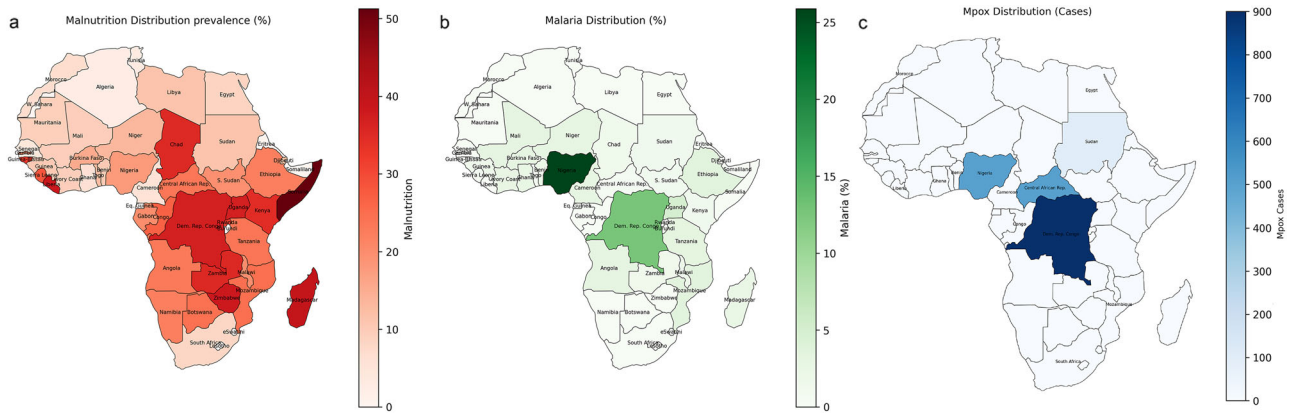

Fig. 1 | Geographical distribution of malnutrition (%), malaria (%), and Mpox cases across African countries. The maps visualize the estimated prevalence of malnutrition, malaria, and Mpox cases at the national level. **a** Malnutrition distribution is shown in shades of red, where darker shades indicate higher prevalence percentages of malnutrition. **b** Malaria distribution is represented in shades of green, with darker shades corresponding to higher malaria prevalence percentages. **c** Mpox cases are displayed in shades of blue, with darker shades representing countries with higher reported case counts. Countries without reported Mpox cases are shown in light gray. Country names are labeled, with affected countries emphasized in bold red text, while unaffected countries are labeled in black for reference. The data was compiled from reported estimates and overlaid on the Natural Earth geographical boundaries. (Data sources: Malnutrition and malaria data were obtained from FAO[15] and WHO[18], and Mpox case estimates were compiled from *Nature Medicine*[19]).

example, in Kenya, mandatory fortification of wheat and maize flour was associated with a 10% decrease in anemia prevalence among women of reproductive age over four years[22], and Nigeria observed a notable reduction in neural tube defects after mandating folic acid fortification in industrially milled flours[23].

Nonetheless, LSFF has not been sufficient to fully eliminate micronutrient deficiencies, particularly in low-resource settings. Barriers such as uneven access, limited consumer awareness, and gaps in regulatory oversight highlight the need for complementary approaches that go beyond national-scale fortification programs.

One notable program is the OBAASIMA initiative in Ghana[24], spearheaded by a partnership among Sight and Life, Royal DSM N.V., the German Federal Ministry for Economic Cooperation and Development, the Children's Investment Fund Foundation, the Bill & Melinda Gates Foundation, the Association of Ghana Industries, and the Ghana Standards Authority[25]. By creating a front-of-package seal guaranteeing 18 essential vitamins and minerals, this effort addresses micronutrient gaps among women of childbearing age. The program illustrates the importance of public-private collaborations in making fortified products more visible, trusted, and readily available in local markets.

Despite these successes, significant barriers remain. Socioeconomic constraints limit access to fortified foods in low-income and rural communities where the food processing sector is often fragmented or minimal[26]. Without concentrated industrial production or robust distribution networks, fortified products are either unavailable or prohibitively expensive for the populations that need them most. Maintaining quality control and ensuring consistent nutrient levels can be challenging when manufacturing capacity and oversight are limited[27]. Also, ethical considerations, such as respecting consumer autonomy and cultural food preferences, require transparent labeling and active community engagement to build trust[14,28]. Additionally, limited consumer awareness about the benefits of fortified foods often leads to low demand, undermining efforts to scale up fortification. In some cases, resistance from local producers, due to perceived costs or regulatory burdens, can further stall implementation[29].

To overcome these challenges, stakeholders are exploring innovative solutions, including advanced packaging technologies and microencapsulation methods to improve nutrient stability and shelf life[30–32]. Such techniques help maintain micronutrient potency, especially in harsh climatic conditions common in parts of Africa. Developing affordable delivery platforms, such as nutritionally enhanced complementary foods or ready-to-use therapeutic foods, can further target vulnerable groups that include infants, young children, and pregnant women. Additionally, strategic policy instruments such as subsidies, tax incentives, or public procurement policies can encourage local producers to adopt fortification practices and make fortified foods more affordable.

Ultimately, a multifaceted approach that combines technological innovation, policy support, public-private partnerships, and community-based education is needed to scale up fortification programs and ensure they deliver lasting improvements in public health. Strengthening regulatory frameworks and harmonizing fortification standards across regions could also reduce compliance burdens and ensure consistently high-quality products.

Conclusions

Malnutrition in Africa continues to pose a severe threat to individual health, societal well-being, and economic stability by increasing susceptibility to both communicable and non-communicable diseases. Food fortification, proven to be a safe and cost-effective method, is gaining traction as a critical strategy to combat micronutrient deficiencies and thus reduce disease burdens across the continent. By integrating food fortification within broader health, agriculture, and education policies, African nations can make significant strides toward improving their population's nutritional status and long-term resilience. Strengthening local infrastructure, engaging communities, and promoting cultural acceptance of fortified products will be integral to these endeavors. Advances in technologies for nutrient delivery and packaging further broaden the scope for effective, large-scale interventions. Ensuring sustainable, equitable access to fortified foods can help break the debilitating cycle of malnutrition and disease, fostering healthier and more prosperous societies across Africa.

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Author contributions

X.Y., L.Z., S.M. and A.J. conceptualized and wrote the original draft of the manuscript, X.Y., L.Z., R.L. and A.J. critically reviewed the manuscript. All the authors reviewed and approved the final manuscript.

Competing interests

From FY 2021 to the present, A.J. receives licensing fees (to patents on which she was an inventor) from, invested in, consults (or was on Scientific Advisory Boards or Boards of Directors) for, lectured (and received a fee), or conducts sponsored research at MIT for which she was not paid for the following entities: The Estée Lauder Companies; Moderna Therapeutics; OmniPulse Biosciences; Particles for Humanity; SiO_2 Materials Science; VitaKey. From FY 2021 to the present, R.L. receives licensing fees (to patents in which he was an inventor on) from, invested in, consults (or was on Scientific Advisory Boards or Boards of Directors) for, lectured (and received a fee), or conducts sponsored research at MIT for which he was not paid for the following entities: see https://www.dropbox.com/scl/fi/xjq5dbrj8pufx53035zdf/RL-COI-2024.pdf?rlkey=fwv336uoepiaiyg4e7jz5t4zo&dl=0. All other authors declare no competing interests.

Additional information

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