



CHAPTER 4

Hidden Hunger

Approaches to Tackling Micronutrient Deficiencies

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AROUND THE WORLD, more than 2 billion people are thought to be affected by an often invisible form of malnutrition: micronutrient malnutrition, commonly known as hidden hunger.¹ Vitamin and mineral deficiencies—at least in mild to moderate forms—may not be as observable as wasting or obesity, but their effects are far-reaching. Globally, vitamin A deficiency (VAD) is the leading cause of blindness in children.² Iodine deficiency causes 18 million babies to be born mentally impaired each year.³ And severe anemia caused by lack of iron is associated with the deaths of 115,000 women annually during childbirth.⁴ Vitamin A, iodine, and iron are classified as “the big three,” but deficiencies of other micronutrients, such as folate, zinc, vitamin B12, and vitamin D, are also important.

Many people in developing countries lack the means to grow or buy micronutrient-rich foods, such as animal-source foods (meat, fish, poultry, eggs, milk, and dairy products) and fruits and vegetables. Instead, they rely on nutrient-poor staples, such as rice and maize. Their lack of dietary diversity is exacerbated by poor access to healthcare and

a high burden of disease. Certain deficiencies, such as those of iron, iodine, and vitamin D (due to low exposure to sunshine), are also public health issues in industrialized countries, despite their higher incomes and better health services. In those countries, food high in micronutrients is more expensive than the cheaper, processed foods consumed more frequently in poorer households.⁵

Strategies to combat micronutrient malnutrition generally focus on pregnant and lactating women, infants, and young children—those most at risk from micronutrient malnutrition because they have a relatively greater need for micronutrients. Targeting these populations achieves higher rates of return by improving health, nutritional status, and cognition later in life.⁶ The main approaches to preventing and treating micronutrient malnutrition typically include exclusive breastfeeding (breast milk provides the main source of micronutrients during the first six months of life, apart from iron), dietary diversification to include foods with highly absorbable vitamins and minerals, fortification of staple and complementary foods, control



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Fruits and vegetables, like the ones being sold here at a market in Niger, supply essential vitamins and minerals.

of parasitic infections, and provision of nutritional supplements.⁷ Because vitamin and mineral deficiencies often exist together, newer interventions have focused on multiple micronutrients.

This story focuses on three interventions: universal salt iodization in China, vitamin A programs, and the development of micronutrient powders or “Sprinkles.” All of these interventions have experienced varying degrees of success and hold lessons for the future.

Success in a Pinch of Salt: Universal Salt Iodization in China

Humans require iodine for their health and their cognitive and physical development, and they can

get it naturally in their diets if they eat enough seafood, or crops and livestock grown in areas with adequate iodine in the soils. But people whose diets do not contain enough iodine are susceptible to iodine deficiency disorders (IDDs). These can include goiter (a swelling of the thyroid glands in the neck) and cretinism (severely stunted physical and mental growth caused by maternal iodine deficiency).

Universal salt iodization (USI)—in which all salt for human and livestock consumption is fortified with iodine—is recognized as the most effective and cost-efficient strategy to eliminate iodine deficiency. Estimates for salt iodization suggest that every dollar invested generates up to US\$81 in benefits.⁸

The spread of USI is widely viewed as a shining public health success. Before 1990, only a few countries—including Canada and the United States—were sufficient in iodine, and 130 countries were iodine deficient. Worldwide, fewer than one in five households used iodized salt. By 2011, thanks to global efforts to ensure access to iodized salt for more than two-thirds of the world's population, the number of iodine-deficient countries had plummeted to 32.⁹

China's experience is part of this larger story. The country's consumption of iodized salt climbed from 20 percent in 1990 to more than 97 percent of salt consumed in 2005.¹⁰ How did the world's most populous country turn a patchy program of implementation into a successful scaling up of USI?

Threat to IQ Levels

Iodine deficiency is a longstanding and widespread problem in China. Goiter was first documented in Chinese medical literature as early as 3000 BCE. About 60 percent of China's land is low in iodine, especially mountainous areas where soil leaching occurs, and many communities in western China were affected by a high prevalence of goiter and cretinism. A national survey in 1970 estimated that 35 million people had visible goiter, there were 250,000 affected by cretinism, and 720 million people were at risk for severe or moderate IDD.¹¹ Subsequently the country's iodized salt program was expanded to all IDD-endemic areas, and by the 1980s rates of goiter had decreased and few cretins were being born. However, IDD was still not completely under control because of a combination of irregular salt iodization, ineffective monitoring systems, and lack of political will.¹² And studies in different parts of China showed that the effects of iodine deficiency went even further: IDD was associated with IQs that were significantly lower, by an average of 11 points. In many IDD-endemic areas,

5–15 percent of children had mild mental retardation, with an IQ of 50–69.¹³

This was the insight that made the difference. The recognition that iodine deficiency was damaging children's intelligence—and the implications for human and economic development—had an impact on China's political leadership at the highest level. Organized by the World Health Organization (WHO), UNICEF, the World Bank, and others, a high-level meeting in 1993 brought together national and provincial representatives from different sectors. Among the attendees was then-Vice Premier Zhu Rongji, an economist, who became convinced of the potential benefits of USI and stimulated action on this front. This meeting offered key lessons on advocacy: the importance of presenting a persuasive argument to policy makers—in this case, the high cost of lower intelligence rather than high rates of goiter—and of defining a clear and feasible solution such as USI.¹⁴

From 1993 onward, China showed leadership at both the international and the national level that would pave the way for USI's global uptake. In 1994 the State Council (the highest national policy-making body, headed by Madam Peng Peiyun, the premier's wife) approved a new National IDD Control Program, which introduced mandatory salt iodization and formed a working partnership with the Ministry of Health and the salt industry to make it happen.

Ramping Up Production

At the start of the program, China had the capacity to produce only 40 percent of the iodized salt needed for USI.¹⁵ Much of the salt consumed by households was raw and unprocessed. To ensure an adequate supply of properly iodized salt, China needed substantial funding, technical assistance, and an industry commitment to iodization.

The State Council made two key moves. First, it set up a special fund for USI, with a total

investment of US\$125 million to upgrade production facilities. Second, it recentralized the salt industry as a state monopoly, reversing the move toward privatizing the salt industry that had started in the mid-1980s.¹⁶

These two moves set in motion a series of changes. With the establishment of the national monopoly—the China National Salt Industry Company—China prohibited the sale of non-iodized edible salt. It set up legal enforcement systems, and by 2000, 25,000 salt police were playing a major role in stopping the transport and sales of illegal salt.¹⁷ It made substantial investments in technology and equipment, modernizing 115 salt plants. And it used health education and IDD Days to raise the public's awareness of the adverse effects of iodine deficiency (May 15 is national IDD Day in China).

Thanks to these steps, China's annual production and distribution rose from 5 million tons of salt—not all of it iodized—to 8 million tons of iodized salt in less than seven years.¹⁸ By 2000, China had achieved USI (in other words, more than 90 percent of household salt consumption was iodized), and it had virtually eliminated IDD.¹⁹ This remarkable feat confirmed the program's status as one of the most successful in the world.

Sustaining Success

Although China achieved consistent success on a national level, certain counties in Hainan, Qinghai, Tibet, and Xinjiang—particularly in rural areas with hard-to-reach populations—remained below 90 percent household consumption of iodized salt. International partners such as UNICEF were also raising concerns that China might not achieve complete coverage of iodized salt and might even regress. Their concerns were based on factors such as the country's large size, anticipated privatization of the salt sector, and the technical and behavioral challenges inherent in the USI effort, including ongoing issues with leakage of cheaper, non-iodized salt.²⁰

Monitoring and evaluation are an integral part of China's national IDD surveillance plan: as they develop policies and implement programs, Chinese officials are guided by, for example, an annual survey on the household coverage of iodized salt and a survey of iodine status—measured through urinary iodine concentration in school-age children—every two to three years. New surveys in the 2000s highlighted areas at high risk of both iodine deficiency²¹ and iodine excess, which has been linked with thyroid disease.²² In 2005 an investigation identified regions in the former flood plain of the Yellow River with high levels of iodine in drinking water.²³ Two years later, a survey identified 249 new cases of cretinism and a more than 5 percent goiter prevalence in 40 counties caused by access to raw salt from local salt lakes.²⁴ Clearly, Chinese policy makers needed to adjust the country's USI program to meet these new and continuing challenges.

In response, China has developed a multi-pronged approach. Since 2007, central and local administrations have implemented both an iodized oil supplementation program for targeted populations in remote areas (including children and reproductive-age, pregnant, and lactating women) and subsidies for iodized salt, which has significantly increased consumption.²⁵ For areas at risk of *excessive* iodine intake, non-iodized salt has been made available. And in 2012 China introduced new standards that both lowered the amount of iodine in salt and reduced the range of salt allowed, and it instructed each province to choose its own iodine content (within the permitted range) to match the needs of the local population.²⁶ This move from national to provincial standards is designed to prevent the reemergence of both iodine deficiency and iodine excess.²⁷

Challenges Ahead

The program context for USI has altered significantly in the last 25 years. China was able to chalk

up early and rapid success in scaling up USI partly because of its focus, its vertical approach, and its state monopoly. For countries without this central control, strong political will and a flexible strategy are keys to success in tackling IDD. The Scaling Up Nutrition (SUN) Movement and other relevant movements have proposed a new, more integrated approach to addressing iodine deficiency, one in which iodine programs are embedded in micronutrient policies and strategies rather than serving as standalone interventions.²⁸

Despite substantial progress, an estimated 1.88 billion people globally, including 241 million schoolchildren, still have inadequate iodine intakes.²⁹ Even countries with successful USI programs such as China struggle to reach disadvantaged and marginalized populations, and in industrialized countries mild to moderate iodine deficiency is a forgotten problem.³⁰

Vitamin A: A Changing Story

For decades, vitamin A supplementation has been the recommended approach to treating and preventing vitamin A deficiency, but new thinking is now emerging about how best to reach various populations.

The Spread of Supplementation

Supplementation emerged as the most effective short-term measure for vitamin A deficiency in the mid-1980s to 1990s, when population-based trials in areas of endemic vitamin A deficiency showed impressive results in reducing child mortality by 23–34 percent.³¹ For the past 25 years WHO has recommended universal supplementation programs of twice-yearly doses of vitamin A, striving to achieve more than 80 percent coverage of children aged 6–59 months. (Although the goal is universal coverage, a coverage threshold of at least 70 percent is needed to achieve reductions

in child mortality comparable with large-scale vitamin A trials.) Despite its low cost, the intervention was facing poor coverage rates in the late 1990s. Global partners—including WHO, UNICEF, the Micronutrient Initiative, and the Canadian International Development Agency—focused attention on the issue, helping national governments to scale up vitamin A supplementation through a public-sector approach with free distribution.³² The efforts paid off: global coverage rates of children improved from 16 percent in 1994 to 77 percent in 2009.³³

Success stories from this era include countries such as Mozambique and Zambia with high vitamin A supplementation coverage (99 and 93 percent, respectively).³⁴ These countries succeeded at scaling up by integrating child survival interventions and linking vitamin A supplementation to people's other contacts with the health sector. In 2008, Mozambique introduced Child Health Weeks, which offered vitamin A supplements alongside other interventions such as deworming, mosquito net distribution, and measles vaccination. By offering services closer to people's homes, these events could serve hard-to-reach populations. Zambia was able to scale up combined vitamin A and deworming coverage to more than 80 percent in all but two provinces through similar child health events and innovations such as text messages encouraging parents and caregivers to participate.³⁵ These types of events need a large amount of planning and logistical support, but the pay-off is that they are effective in reaching the majority of children targeted.

Bihar—one of the India's poorest states—has achieved 95 percent coverage of vitamin A supplementation (in sharp contrast to India's 54 percent countrywide coverage) through a partnership between the Government of Bihar, UNICEF, and the Micronutrient Initiative. Bihar's program is designed to target children from scheduled

castes and minority groups, who are traditionally excluded from services. The state has strengthened implementation through a combination of detailed district planning, training of frontline health and nutrition workers and community volunteers to administer vitamin A syrup and nutrition counseling on vitamin A-rich foods, and intensive social mobilization and communication. The program has mobilized more than 11,000 health centers; 80,000 *anganwadis*, or child development centers; and 3,400 temporary sites in isolated communities as distribution sites for vitamin A supplements.³⁶

Looking at Alternatives

Recently, concerns have been expressed that since the 1990s, twice-yearly, high-dose vitamin A supplementation has largely displaced alternative ways of addressing vitamin A deficiency, including opportunities to deal with mild to moderate vitamin A deficiency in women and children.³⁷ Supplementation programs for vitamin A were originally intended to be a short-term solution to be phased out and replaced by more sustainable food-based or fortification measures. Moreover, changing disease patterns—particularly reductions in measles and diarrhea—may have made periodic high-dose vitamin A capsules less relevant today (vitamin A deficiency is a risk factor for measles-related mortality and diarrhea-related mortality).³⁸ Critics claim that only one large-scale program evaluation—the DEVTA trial, ending in 2003, in Uttar Pradesh, India³⁹—has ever been published, and it showed no impact on the mortality of children aged 1–6 years (although inclusion of the DEVTA data with results from previous trials still showed a significant effect on mortality from vitamin A supplementation, albeit reduced from 20–30 percent to 11 percent).⁴⁰ An analysis of recent randomized controlled trials suggests that high-dose vitamin A supplementation may even have harmful effects in some subgroups.⁴¹ Options are now being sought to

both expand on the current “one-size-fits-all” supplementation approach and reduce disparity in vitamin A status using creative local solutions that directly confront nutrition and dietary conditions.⁴² For example, unlike high-dose vitamin A capsules, daily or weekly supplements are safe for reproductive-age women.

Supplementation is probably the most widespread intervention, but other successful strategies for increasing people’s vitamin A intake, particularly food-based approaches, are now coming to the forefront. Dietary diversity programs such as Bihar’s combine supplementation with counseling on vitamin A-rich foods. A number of countries have implemented mass fortification of staple foods with vitamin A at the national level, including edible oil (Morocco), wheat flour (Philippines), and sugar (Guatemala and Zambia).⁴³ Some studies have found fortification to be cost-effective but lacking sufficient coverage since it left “too many” micronutrient-deficient people.⁴⁴ Biofortification programs promoting consumption of crops high in vitamin A, including orange-fleshed sweet potatoes, are being scaled up in countries such as Mozambique and Uganda (see Chapter 6 on agriculture).

A Sprinkle of Success

Iron-deficiency anemia (IDA) is the most prevalent form of micronutrient deficiency: WHO estimates that IDA affects about 47 percent of pre-school-aged children and 42 percent of pregnant women, mostly in Africa and Asia.⁴⁵ Young children are particularly vulnerable because they have high iron needs (their fetal iron stores are depleted four to six months after birth) and the cereal-based diets they are typically weaned on are low in iron.⁴⁶ Historically, children at risk for anemia were given iron syrups and drops, but they often do not adhere to these because these supplements can have a strong metallic taste and lead to teeth staining and



Micronutrient Initiative

A Pakistani mother pours micronutrient powder, commonly known as Sprinkles, onto her child's food to help prevent micronutrient deficiencies.

abdominal discomfort.⁴⁷ Moreover, the supplements have a short shelf life and, because they are heavy, high transportation costs.

Inventing Sprinkles

In the late 1990s, the search for a more palatable alternative led a Canadian doctor, Stanley Zlotkin, to invent micronutrient powders (MNPs), frequently referred to by the brand name Sprinkles. MNPs come in single-serving, one-gram packets—inspired by ketchup sachets—containing premeasured vitamins and minerals, including specially coated iron. These powders can be mixed into a child's usual foods at home for instant fortification. They require minimal behavior change and no additional work for women. Two common product formulations are currently in use: one contains

5 micronutrients (initially called “anemia formulation”), and the other has 15 micronutrients (considered optimal for complementary feeding). A standard course of treatment is 60 sachets.⁴⁸ A review of eight trials found Sprinkles to be effective—home use of MNPs was associated with a reduced risk of anemia and iron deficiency in children under two.⁴⁹

MNPs were first endorsed by WHO in 2007 to improve the iron and anemia status of populations affected by emergencies and strongly recommended in 2011 as a public health intervention.⁵⁰ Mongolia was the first country to pilot Sprinkles, and it scaled up their use to the national level in three phases over a 10-year period. The country's story and the challenges it faced are both generic to the intervention and context-specific, but all of them

provide food for thought on how to tackle hidden hunger, and IDA in particular.

Mongolia's interest in the intervention began in 1997, when a national survey of iron and vitamin D deficiency in Mongolia generated alarming findings: among children 6–59 months old, 46 percent had anemia and 28 percent had rickets—a painful, bone-deforming disease caused by lack of vitamin D (one symptom is bowed legs).⁵¹ In response, the Ministry of Health collaborated with World Vision to deliver an integrated nutrition package targeted to pregnant and breastfeeding women and children under age five in underdeveloped areas. As part of this package, Sprinkles were distributed free of charge to more than 14,000 children 6–36 months old.⁵² The sachets contained powders specially formulated to address the high levels of anemia and rickets in Mongolia, wrapped in culturally acceptable packaging bearing local-language instructions and artwork.

Success in Addressing Anemia: The Mongolia MNP Pilot

The pilot phase of Mongolia's Sprinkles project in 2002–2004 faced several obstacles. Advocates had gained the support of a key Ministry of Health secretary, but otherwise the project had little political support. The country's public health care system had limited capacity, so the delivery system relied on World Vision's resources, undermining the project's sustainability. And the Sprinkles were originally more expensive than supplementation.⁵³

But the pilot phase achieved promising results. Sprinkles were distributed to more than 88 percent of children 6–36 months old in the program areas, and the prevalence of anemia fell from 55 percent in 2002 to 33 percent in 2004 (although rickets did not decline). The program had other components, such as prenatal iron supplements and activities encouraging consumption of iron-rich foods, that may have contributed to this result. But an

evaluation showed that 93 percent of children 6–36 months old who used Sprinkles did so at least three times a week, and this group had a lower prevalence of anemia (31 percent) than those who used Sprinkles less often (52 percent).⁵⁴

The success of this pilot approach proved to be a powerful advocacy tool, winning new supporters and paving the way for scaling up from scattered communities to an entire province. From 2005 to 2010 the intervention was scaled up in Selenge province in northeast Mongolia, with funding secured from a Canadian mining company with operations in the province. The project partners—the Ministry of Health and World Vision—incorporated lessons learned from the pilot phase. They sought technical expertise to help adjust the amount of vitamin D in the Sprinkles, provided vitamin D supplements, and launched additional behavior change initiatives. They also found ways to produce the Sprinkles more cheaply. There was still no network of community nutrition workers in this phase, so the partners raised awareness through leaflets and televised educational messages and improved delivery by distributing Sprinkles at health posts during immunizations. Finally, they recruited volunteer mothers to help mobilize communities and monitor the use of Sprinkles.⁵⁵

Again, the results for this phase were convincing: the intervention reached 7,000 children under 5 years old and 1,300 pregnant women and new mothers in the province. The prevalence of rickets fell the most, from 62 to 25 percent between 2005 and 2010, but the prevalence of anemia in children also declined from 26 percent to 22 percent, and stunting levels fell from 26 percent to 9 percent in the same period.

Part of National Health Policy

The phased approach allowed Mongolians to determine that the innovation was appropriate and successful in their own context,⁵⁶ and

the government accepted Sprinkles as an effective tool in its battle against childhood anemia. In 2009, the Ministry of Health launched Phase III, a national program targeting 50,000 children 6–24 months old in certain provinces based on poverty levels, health indicators, and geographical access. Ongoing technical and financial support was provided by the Asian Development Bank, World Vision, and UNICEF.⁵⁷ The establishment of Micronutrient Working Groups at national, provincial, and district levels was essential to both the provincial and national scale-up.⁵⁸ The partners have worked to build the capacity of existing systems and programs to ensure that Sprinkles are delivered through the public health care system and integrated within current mother and child health programs.⁵⁹ The Mongolian story shows that scale-up is feasible: the government went from being a detached observer at the pilot stage to taking ownership of the intervention, and Sprinkles have now become part of Mongolia's national health policy.

Despite the evidence on impact⁶⁰ and cost effectiveness (MNPs cost about US\$0.03 per sachet, or US\$1.80 per 60-sachet course, to public sector buyers),⁶¹ just a handful of countries to date have implemented large-scale distribution. These include Bangladesh, Bolivia, Dominican Republic, Kyrgyzstan, and Mongolia. There are pilot programs in about 55 other countries,⁶² and Afghanistan, Cambodia, and Tanzania are using MNPs in pilot school-feeding programs targeting children and adolescents.⁶³ The number of sachets distributed by UNICEF and the World Food Programme (WFP) rose from 50 million in 2008 to about 350 million in 2010,⁶⁴ but this intervention

reaches only about 13.6 million children—less than 5 percent of anemic children globally. The role played by Sprinkles in tackling Mongolia's micronutrient deficiencies offers a success story from which other countries can take inspiration.

Lessons Learned

While it is not possible to generalize about what works in scaling up micronutrient interventions from a few case studies, the experiences described here share some common elements. Both universal salt iodization in China and the Sprinkles intervention in Mongolia relied on a staged approach—from pilot to district to national level—that afforded opportunities to iron out issues such as the levels of micronutrients required by different populations. In both countries, nutrition champions in influential positions, secured through effective advocacy, ensured support and government buy-in for the interventions. Micronutrient programs such as vitamin A supplementation and Sprinkles are often led by donors initially, but integrating these interventions into existing broader health programs and training community volunteers can help make them more sustainable. This shift occurred in the merging of vitamin A supplementation with Child Health Weeks in Mozambique and Zambia and the adoption of micronutrient powders into Mongolia's national health policy. Ongoing monitoring and evaluation of such programs are crucial for gauging whether interventions are still relevant: today's micronutrient success stories such as universal salt iodization and vitamin A supplementation may be eclipsed by other strategies in the near future, such as fortification or food-based initiatives.

