Investing in the future

A united call to action on vitamin and mineral deficiencies

GLOBAL REPORT 2009

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The global community should be outraged by the millions of children that either die or are disabled each year because of malnutrition. We know how to prevent and treat it. The missing link is the political will to place nutrition squarely on the development agenda and to commit the necessary resources to implement programs, particularly food fortification, that we know can deliver sustainable improvements not only to the current generation of people at risk but to the lives of generations to come.

Marc Van Ameringen, Executive Director, GAIN

We encourage all of our industry peers to find their niche in these proven, cost-effective strategies to reduce vitamin and mineral deficiencies around the world.

Scott Montgomery, Vice President and Global Procurement Leader, Cargill Inc.,
FFI Executive Management Team Chairman

The global community has committed, through the Millennium Development Goals, to meet the rights and needs of all the world's citizens. We are working to reduce poverty and child mortality, improve maternal health, provide universal primary education and ensure gender equality. Empowering people in all countries to consume adequate amounts of essential micronutrients plays an important role in meeting these objectives.

Venkatesh Mannar, President, Micronutrient Initiative

Good nutrition, especially in the first years of a child's life, provides lifelong benefits in health, education and productivity. However, one in four children under-five in the developing world – approximately 148 million children – suffer from undernutrition. Affordable and proven micronutrient interventions to address undernutrition exist. We must work collectively to scale up access to these micronutrients, so children everywhere have the chance to reach their full potential and contribute to the development of their communities.

Ann M. Veneman, Executive Director, UNICEF

At least two children die every minute of every day because they have not received the protection vitamin A supplementation can provide. In the span of two decades, micronutrient supplementation programs have become a mainstream national health goal to reduce childhood mortality and morbidity in 70 countries. The goal now must be to ensure that every vulnerable child receives the vitamin A they require.

Alfred Sommer, Dean Emeritus and Professor, Johns Hopkins University

The development and production of this report was funded by
the Micronutrient Initiative, with the financial support of the Government of Canada
through the Canadian International Development Agency (CIDA).

ISBN: 978-1-894217-31-6

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Executive Summary

A young girl in Ethiopia being administered vitamin A. Approximately one third of the developing world's children under the age of five are vitamin A-deficient, and therefore ill-equipped for survival. © MI

VITAMINS AND MINERALS ARE VITAL COMPONENTS of good nutrition and human health, advancing physical and intellectual development in many important ways. A number of vitamins and minerals – also known as micronutrients – are particularly important because of the large numbers of people around the world who are deficient in them. These are vitamin A, iodine, iron, zinc and folate.

Around the world, billions of people live with vitamin and mineral deficiencies. For instance, approximately one third of the developing world's children under the age of five are vitamin A-deficient, and therefore ill-equipped for survival. Iron deficiency anaemia during pregnancy is associated with 115,000 deaths each year, accounting for one fifth of total maternal deaths.

Children, whose mothers died giving birth, may be neglected. Children who themselves have insufficient micronutrient intake and absorption can suffer serious lifelong repercussions. If they survive infancy, their bodies may be weak and prone to disease. They may have birth defects or become blind. They may not go far in school.

When whole populations suffer from malnutrition, including a lack of critical vitamins and minerals, nations likewise cannot fulfill their potential. Health-care costs rise, education efforts are thwarted, the workforce is less capable and productive, and economic activity is curtailed. Human capital overall is significantly diminished.

Yet there is encouraging news from many corners. Working together, national governments, donors, science and industry have made huge strides in delivering cost-effective solutions to vulnerable populations. These successes, if further scaled-up, present exciting opportunities to improve the lives of those who have thus far not been reached.

The Causes of Vitamin and Mineral Deficiencies

The causes of vitamin and mineral deficiencies are multiple and interconnected. At the most basic level, the problem is related to diet. Throughout the world, poor people do not consume sufficient amounts of nutrient-rich foods such as meat, eggs, fish, milk, legumes, fruits and vegetables. The problem is made worse by inadequate health care and sanitation, disease, and a lack of education in infant and childcare.

Quality, varied diets would resolve most vitamin and mineral deficiencies. However, improving the diets of the world's poor is a complex and long-term undertaking that is largely dependent on rising incomes, improved access to food, better health and nutrition services delivery, and changing infant and young-child feeding practices. Well-integrated strategies to address nutrition at the national level will be critical for long-term success in reducing malnutrition, improving health, educational achievement, and economic productivity. In the short term, however, many lives can be saved and improved through a range of cost-effective interventions, including supplementation and fortification.

Call to Action: Solving Vitamin and Mineral Deficiencies through Partnerships

The successful delivery of large-scale interventions requires broad-based partnerships. National governments take the lead by identifying needs, setting and monitoring national policy and standards, budgeting for micronutrient programmes, training health-care providers, and launching social marketing and education campaigns. Their long-term commitment is vital.

Non-governmental organizations can support this commitment with expertise in programme design and delivery, continuing research, advocacy, and the procurement of products. International donors – governments and philanthropic groups alike – help across the board, by assisting with large-scale procurement, boosting global supplies, and covering implementation costs.

Internationally and locally, the private sector brings its pharmaceutical and food processing expertise and ingenuity to produce, promote, and ensure quality control. Small-scale processors and farmers also play key roles. Partnerships have created some stunning successes in the past decade.

Vitamin A – Research has shown that, where a population is at risk of vitamin A deficiency, vitamin A supplementation reduces mortality in children between six months and five years of age by an average of 23%. Global efforts to provide young children with twice-yearly supplements have involved 103 countries. In 1999, just 16% of children in these countries received full supplementation. By 2007, that number had more than quadrupled to 72%.

Salt iodization – When the power of iodine is unleashed through intake of iodized salt, the results are impressive. In communities where iodine intake is sufficient, average IQ is shown to be on average 13 points higher than in iodine-deficient communities. Between 1993 and 2007, the number of countries in which iodine-deficiency disorders were a public health concern was reduced by more than half, from 110 to 47.

Like these successes, other approaches have shown great promise. One approach is food fortification, which is the process of adding vitamins and/or minerals to foods to increase their overall nutritional content. Multiple micronutrient solutions, whether in packets for in-home use or delivered through clinics and public campaigns, warrant urgent and wide expansion.

The Best Investment in the World

As the global financial crisis unfolds and available funds from all sources are shrinking, the need for development assistance is expanding at an alarming pace. It is more important than ever that priority for investments goes to measures that yield the highest rates of return.

Micronutrients are inexpensive commodities. Low-cost supplements and fortificants are already available. For instance, it is estimated that the cost of salt iodization is a mere five cents per person per year. Vitamin A capsules cost two cents each. Micronutrient initiatives can easily be integrated into ongoing health services, or into existing methods for food production.

With the low cost of interventions and their high returns in improved capacity, the benefit:cost ratio of micronutrient programming is unmatched by any other large-scale health or economic intervention.

This simple truth has been endorsed by a panel of eight of the world's most distinguished economists. In May 2008, the Copenhagen Consensus panel considered 30 options and ranked the provision of micronutrients as the **world's best investment for development**.

They determined that vitamin A and zinc supplementation for children provided the very best returns: an annual investment of US$ 60 million would yield benefits worth more than US$ 1 billion per year. Micronutrient fortification ranked third; biofortification ranked a close fifth.

Achieving the Millennium Development Goals by 2015 will require strategic vision on the part of all those with resources to invest. Much is already understood about early nutrition needs and what works. Commitment and funds, supported by strong partnerships, will extend the reach of micronutrient interventions and leave no one behind.

Summary of Recommendations

Delivering vitamins and minerals to large populations involves commitment, coordination, planning and cooperation – all held together by strong and durable partnerships. Key partners in micronutrient interventions include national governments, non-governmental organizations, donors, aid agencies, foundations, industry, community leaders, and the agricultural sector.

The following provides a number of priority actions for each intervention that should be undertaken by national governments, industry and international organizations.

Vitamin A

- ✔ Scale up the delivery of integrated package of health services, including twice yearly vitamin A supplementation for children aged between 6 months and five years, to achieve at least 80% coverage on a recurrent basis.
- ✔ Target the hard-to-reach through complementary strategies, such as special outreach programmes, to reach the final 20% who have not been reached through regular programmes.
- ✔ Improve programme sustainability by mobilizing resources in national budgets to cover costs pertaining to vitamin A supply and local distribution.
- ✔ Establish integrated delivery strategies, monitoring of programmes, and tracking of progress.

Salt Iodization

- ✔ Enact mandatory legislation and ensure adequate resources are made available to enforce it.
- ✔ Build financial sustainability to transition from a donor-supported to a market-supported supply of iodate.
- ✔ Undertake strategic advocacy and communication efforts through media, health systems, and schools.
- ✔ Strengthen population-monitoring systems so that programme adjustments can be made as habits and diets change over time.
- ✔ Create incentives for processors to iodize their salt.

Food Fortification

- ✔ Set and monitor national standards for food fortification programmes and ensure standards are enforceable, so that all producers have equal financial obligations.
- ✔ Identify and train fortification champions from both public and private sectors to build on success to date and help rapidly expand fortification efforts.
- ✔ Launch communication and public education initiatives to create a market demand for products and support for government investment.

Summary of Recommendations *Continued*

Multiple Micronutrient Supplements for Children

- ✔ Scale up availability of multiple micronutrient supplements for in-home use, such as Sprinkles, in non-malaria endemic regions.
- ✔ Direct research efforts to find safe and cost-effective ways to improve iron intake by young children in malarial areas.

Supplements for Women of Child-bearing Age

- ✔ Expand and scale up iron and folic acid supplementation for all women of child bearing age, with special focus on pregnant women.
- ✔ Bring increased focus on improving adherence rates, through community outreach, counselling, and related efforts.
- ✔ Explore the feasibility of providing women with multiple vitamin and mineral supplements.

Zinc Supplementation for Diarrhoea Management

- ✔ Incorporate zinc supplementation into national diarrhoea management policy.
- ✔ Ensure zinc supply.
- ✔ Identify public and private delivery strategies.
- ✔ Create demand through social marketing campaigns.
- ✔ Provide adequate financing for start-up.

Food-based Approaches

- ✔ Research best practices for community-based programmes – including nutrition-education approaches and operational solutions that can be replicated and supported by local institutions.
- ✔ Integrate micronutrient interventions with existing health, nutrition, and food security programmes.
- ✔ Provide regionally based technical assistance to ensure quality programme delivery.

1 Introduction

MICRONUTRIENTS – OR VITAMINS AND MINERALS NEEDED IN SMALL QUANTITIES – are essential to a good start in life and robust growth and development. In particular, vitamin A, iodine, iron, zinc and folate play pivotal roles in maintaining healthy and productive populations.

With them, a young child has a chance to survive and thrive, learn and stay in school, and grow into a productive adult. Without them, a child's full potential can be lost forever. Likewise, when whole populations do not have access to basic vitamins and minerals, nations suffer enormous lost potential. Widespread deficiencies cripple health-care budgets, undermine education efforts, weaken a workforce, and debilitate an economy.

Around the world, at least two billion people live with vitamin and mineral deficiencies. The delivery of micronutrients to those who need them is a giant undertaking, but one that has already seen some significant successes benefitting large populations.

Many micronutrient programmes have yielded well-documented returns in improved physical and intellectual capacity. With increased long-term investment by national governments and their partners in development, they could yield much more. Emerging new programmes, which are affordable, feasible and well-grounded in science, are now also available to help expand still further the potential benefits offered by micronutrients.

The relatively low cost and high returns of micronutrient interventions are so good they have won the highest praise from the world's top economists. In 2008, the Copenhagen Consensus panel determined that vitamin A and zinc supplementation for children provided the very best return on investment across all global development efforts. Fortifying foods with iron and iodine was ranked third and biofortification ranked fifth out of a total of 30 possible programme choices, showing that across the board, micronutrient interventions are some of the most cost-effective development efforts.

Chapter 1 introduces the report's key themes:

- ✔ the importance of vitamins and minerals (micronutrients), and the costs of deficiencies to individuals and societies
- ✔ the proven and impressive cost:benefit ratio of micronutrient programmes
- ✔ how micronutrient interventions move us toward Millennium Development Goals
- ✔ the implications of volatile commodity markets and global financial instability for the world's poor

A mother and daughter in rural Bolivia. Vitamins and minerals play important roles in human development and physical well-being. © MI

Table 1. How micronutrient interventions support Millennium Development Goals

MILLENNIUM DEVELOPMENT GOAL	MICRONUTRIENT ROLE
GOAL 1 – ERADICATE EXTREME POVERTY AND HUNGER	• iron intake can reduce anaemia – leading to greater productivity and earning potential • salt iodization reduces iodine deficiency disorders – increasing learning ability and intellectual potential, and leading ultimately to better-educated citizens earning higher wages • zinc reduces stunting among children
GOAL 2 – ACHIEVE UNIVERSAL PRIMARY EDUCATION	• salt iodization reduces iodine deficiency – improving cognitive development and learning potential • iron in young children improves cognitive development to help them succeed academically later in life • zinc reduces the frequency and severity of diarrhoea – decreasing the number of school days lost • vitamin A prevents childhood blindness • folic acid prevents disability due to neural tube defects
GOAL 3 – PROMOTE GENDER EQUALITY AND EMPOWER WOMEN	• iron improves women's economic productivity • addressing under-nutrition empowers women more than men: improved micronutrient intake by women can help to correct inequalities in their access to adequate and nutritious food
GOAL 4 – REDUCE CHILD MORTALITY	• vitamin A significantly improves child survival rates • zinc reduces the frequency and severity of diarrhoea, a major cause of child mortality • salt iodization reduces iodine deficiency – lowering rates of miscarriage, stillbirth and neonatal death
GOAL 5 – IMPROVE MATERNAL HEALTH	• iron improves maternal survival rates • salt iodization prevents iodine deficiency disorders and its consequences such as spontaneous abortion, stillbirth, and impaired mental function

Millennium Development Goals

The belief that every human being has the right to benefit from scientific, technical, and social progress underpins the Charter of the United Nations of 1945. It was later enshrined as rights in the Declaration of Human Rights and the Convention on the Rights of the Child. At the outset of the millennium, the world's leaders set specific goals and a timeline of 2015 to bridge the gap between rights and reality for the world's poor.

Achieving the Millennium Development Goals (MDGs) by 2015, especially as the world adjusts to financial challenges, will require strategic vision on the part of those with resources to invest. Micronutrient interventions offer the world excellent and proven opportunities to meet these goals. As seen in Table 1, the provision of key vitamin and mineral interventions supports the realization of the MDGs in a variety of ways.

Prioritization of investments with high rates of return has become more important than ever.

The Escalating Number of Poor People

Recent trends in commodity markets and the worldwide financial situation are accelerating the numbers of people at risk of vitamin and mineral deficiencies. In 2007, the Food and Agriculture Organization index of food prices rose by 24%, and rose again by 51% between October 2007 and October 2008.[1] In November of 2008, the World Bank estimated that high food and fuel prices had increased the number of extremely poor by at least 100 million people, and had set back seven years of progress in meeting the MDG target for the reduction of poverty.[2]

The World Bank also estimated that in 2008 alone, increased food prices may have been responsible for an additional 44 million children experiencing permanent physical and cognitive setbacks due to malnutrition.[3]

The global financial crisis spells more bad news. National government revenues are down, jeopardizing budgets for health and education. Donor government revenues are also lower, jeopardizing overseas development expenditures.

Taken together, the financial crisis and underlying factors of increasing demand and expected future volatility in commodity markets have made the prospects for the world's poor especially grim. Prioritization of investments with high rates of return has become more important than ever.

Micronutrient intake decreased during Indonesia's financial crisis, leading to higher rates of anaemia

During Indonesia's financial crisis in the 1990s, families decreased their consumption of foods rich in vitamins and minerals. © MI

Poor women and children are especially susceptible to vitamin and mineral deficiencies. During economic crises, their vulnerability is much greater. Higher food prices and lower incomes usually force them to reduce their intake of foods that are high in micronutrient content.

A study of how the Indonesia financial crisis of the late 1990s affected micronutrient consumption confirmed this. The authors found that, among the poor, household consumption of eggs and dark leafy vegetables (both important sources of micronutrients) fell significantly.[4] This reduction in consumption of quality foods between December 1996 and July 1998 (approximately the peak crisis period) resulted in increased prevalence of anaemia for both mothers and children. In fact, the study found that anaemia rates among children increased from 52% to 68% during the period. The effects were particularly severe for children conceived during and immediately prior to the crisis.

With compelling evidence that adult labour productivity lost as a result of childhood iron-deficiency anaemia can lead to significant losses in gross domestic product (GDP), the long-term effects of such consequences of financial crises are staggering.[5]

2 How Micronutrients Affect Human Health

Chapter 2 briefly describes the benefits of:

- ✔ vitamin A
- ✔ iodine
- ✔ iron
- ✔ zinc
- ✔ folate

SINCE THE EARLY 20TH CENTURY, scientific and technical discoveries have led to improved health and prosperity for those who have been able to benefit from them. One is the discovery that food contains important vitamins and minerals, and that a deficiency in some of these can cause a range of health and developmental problems.

As research progresses and micronutrient interventions expand, evidence continues to emerge of their impressive impact on survival and development. Remarkably powerful for the tiny levels required, micronutrients support an array of critical biological functions including development of the brain and the nervous system, skeletal development and growth, immune function, and eye function.[6]

Five micronutrients stand apart, both because of their importance and the numbers of people who are deficient in them. These micronutrients have become the focus of highly successful programmes that have reached millions of children and adults. Table 2 shows just how much difference they make.

VITAMIN A: Vital for survival and sight

Thanks to its powerful ability to boost the immune system, vitamin A is a critical micronutrient for the survival and physical health of children exposed to disease.

This significant contribution to child health was first explored in the mid 1980s in Indonesia. A study showed remarkable reductions in deaths of children under five years of age when supplemented with vitamin A.[7] Subsequent research showed that, where a population is at risk of vitamin A deficiency, supplementation reduces mortality in children between six months and five years of age by an average of 23%.[8]

In preventing blindness in childhood, few factors are as important as levels of vitamin A. Also known as retinol, it is indispensable to the retina's ability to adapt to dark lighting conditions. People without this ability suffer from night blindness, which is the inability to see shapes in low light.

Vitamin A also promotes healthy eye surface membranes, helping prevent scarring of the cornea. This makes adequate vitamin A vital for the prevention of a widespread condition called xerophthalmia, a serious eye disorder that is the primary cause of sight loss among the five million visually disabled children in the world.[9] Studies have shown reductions of up to 70% in the prevalence of xerophthalmia in children after sustained vitamin A supplementation.[10]

Young children in Gonaives, Haiti. Iodine is one of the most important elements required by a developing fetus because of its effect on brain development.
© MI

Table 2. Micronutrients: at the core of survival, development and health

MICRONUTRIENT	IMPACT THROUGH PROGRAMMES
VITAMIN A	• 23% reduction in under-five mortality rates • 70% reduction in childhood blindness
IODINE	• 13-point increase in IQ
IRON	• 20% reduction in maternal mortality
ZINC	• 6% reduction in child mortality • 27% reduction of diarrhoea incidence in children
FOLATE	• 50% reduction in severe neural tube birth defects, such as spina bifida

IODINE: Fundamental for the intelligence of the next generation

Iodine is one of the most important elements required by a developing fetus because of its effect on brain development. While the link between iodine and goitre – the most visible effect of severe iodine deficiency – has been known since the early 20th century,[11] it was not until the 1970s and 1980s that the links between iodine and fetal cognitive development began to be understood.[12]

When the intake of iodine is increased through the consumption of iodized salt, the results are impressive. In communities where iodine intake is sufficient, average IQ is shown to be on average 13 points higher than in iodine-deficient communities.[13]

IRON: Essential for maternal and fetal health, learning, and productivity

Iron is an essential mineral for human development and function. It helps produce haemoglobin, the oxygen-carrying component of red blood cells. As these cells carry oxygen to the muscles and brain, iron is critical for motor and cognitive development in childhood, and for physical activity in all humans. If iron levels are too low, the body makes too few red blood cells, and individuals develop anaemia.

Iron is also critical to the health of a pregnant mother and her unborn child. A woman needs more iron during pregnancy because the fetus and placenta both need additional iron. Iron supplementation during pregnancy lowers the risk of maternal mortality due to haemorrhage, the cause of more than 130,000 maternal deaths each year.[14] Supplementation also helps to lower the risks of premature birth and low birth weight.

Eliminating anaemia in adults can result in productivity increases of up to 17%. These increases are equivalent to 2% of GDP in the worst affected countries.

Studies have shown that infants with anaemia caused by iron deficiency have lower mental scores and lower motor scores than infants without anaemia.[15] Ensuring sufficient iron levels in the first months and years of life is, therefore, critical.

ZINC: Fights diarrhoea and infections and promotes growth

Zinc promotes immunity, resistance to infection, and the growth and development of the nervous system. It also promotes the production of antibodies against intestinal pathogens.[16]

Diarrhoeal disease causes 18% of deaths in children under five years of age.[17] Studies have shown that zinc supplementation, given with oral rehydration therapy, can

Children play in a village in Nepal. Zinc supplements, when used in addition to oral rehydration, reduce the duration of persistent diarrhoea by approximately 27%. © MI

reduce the incidence of diarrhoea in children by 27%.[18] It can also reduce the incidence of acute lower respiratory tract infections by 15%.[19] A 10–14-day course of zinc supplementation has also been shown to increase children's resistance to further episodes of diarrhoea and other disease for two to three months following supplementation.[20]

FOLATE: Essential for healthy fetal development

In the earliest days of fetal development, folate is one of the most important micronutrients for the emerging human being. Necessary for the production of new cells, folate promotes the healthy early development of the spine, spinal cord, skull and brain.

Debilitating and sometimes deadly neural tube defects – including spina bifida – occur three to four weeks after conception if part of the neural tube does not close as it is developing. Ensuring sufficient levels of folate in women prior to conception has been shown to reduce by 50% the number of cases of neural tube defects.[21]

3 The Costs of Vitamin and Mineral Deficiencies

THE FIRST 1,000 DAYS – from conception until the age of two – are the most critical for any child. After birth, if exclusive breastfeeding is not practised during the first six months of life or if the solid foods introduced after that period are nutrient-poor, young children are likely to suffer vitamin and mineral deficiencies.

Up to two billion people suffer the consequences of vitamin and mineral deficiencies.

Deficiencies lead to more frequent infections, reduce children's ability to fight and survive disease, and impair mental capacity. These risks remain serious as children grow and develop. They cannot learn as well, and lose school days due to illness.

In adulthood, vitamin and mineral deficiencies negatively affect physical energy and, therefore, productivity. Deficiencies during pregnancy threaten the health and lives of women and impact their unborn children.

Chapter 3 explores the repercussions of vitamin and mineral deficiencies, from conception to adulthood, including:

- ✔ child and maternal deaths
- ✔ physical disabilities
- ✔ lowered intellects
- ✔ lost productivity
- ✔ burden on caregivers and health-care systems

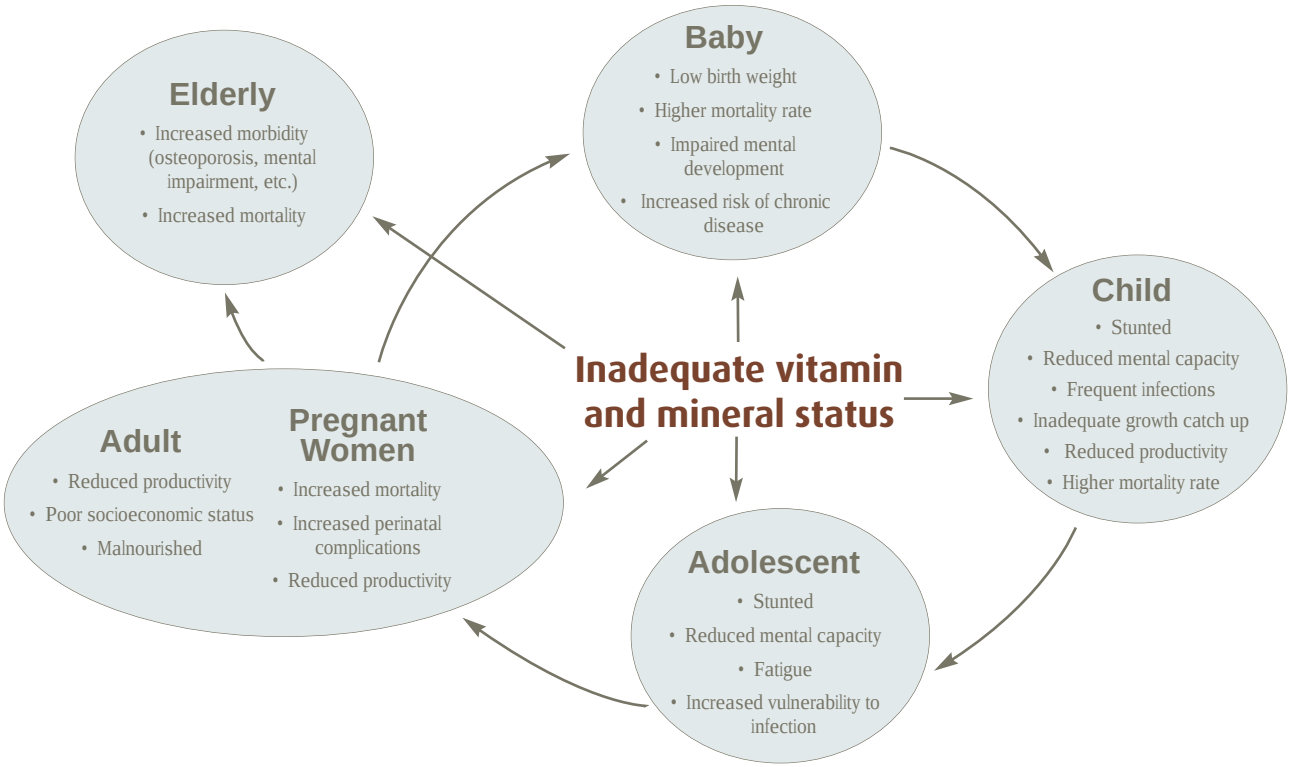
Lives Lost

The most unacceptable effects of vitamin and mineral deficiencies are unnecessary child and maternal deaths. For too many, death comes with pregnancy and birth, and for even more it comes after battles with disease.

Table 3. Human toll of vitamin and mineral deficiencies

TYPE OF REPERCUSSION	NUMBERS AFFECTED
LIVES LOST ANNUALLY	• 1.1 million children under five die due to vitamin A and zinc deficiencies • 136,000 women and children die because of iron-deficiency anaemia
LIVES IMPAIRED ANNUALLY	• 18 million babies are born mentally impaired because of maternal iodine deficiency • 150,000 babies are born with severe birth effects due to inadequate maternal folate intake • 350,000 children become blind due to vitamin A deficiency
LOST PRODUCTIVITY	• 1.6 billion people suffer reduced productive capacity due to anaemia

Figure 1. Consequences of vitamin and mineral deficiencies during the life cycle



Adapted from the United Nations Administrative Committee on Coordination Sub Committee on Nutrition (ACC/SCN), Fourth Report on the World Nutrition Situation, 2000, Geneva: ACC/SCN in collaboration with IFPRI.

1,000 days that can last a lifetime – if vitamin and mineral deficiencies are not corrected between conception and the age of two, it may be too late to correct them later.

Deficiencies in vitamin A and zinc are particularly dangerous for children who are fighting measles, diarrhoea and malaria. A full 20–24%[22] of deaths from these three diseases are attributable to inadequate vitamin A or zinc. Vitamin A deficiency annually claims the lives of almost 670,000 children under five and zinc deficiency claims more than 450,000.[23] Approximately one third of the world's children under the age of five have inadequate dietary intake of vitamin A and are, therefore, ill-equipped for survival.[24]

Iron-deficiency anaemia during pregnancy is associated with 115,000 women's deaths each year,[25] which account for one fifth of total maternal deaths.[26] This has the additional result of leaving tens of thousands of children without the protective care of their mothers and at further risk of illness and death. Iron-deficiency anaemia is also estimated to cause almost 600,000 stillbirths or deaths of babies within their first week of life.[27]

One fifth of all maternal deaths are associated with iron-deficiency anaemia during pregnancy.

Lives Impaired

While the number of children and women who die because of vitamin and mineral deficiencies is great, greater still is the number of people who live with these deficiencies and their consequences. The negative impact on their health and well-being is significant. More often than not, they suffer multiple deficiencies and, therefore, multiple impairments.

Lowered intellect

Reduced intellectual capacity undermines investments in

A young man shares a poster about the effects on the thyroid gland of iodine deficiency disorders (IDD) with a group of adolescents. They are part of a peer-to-peer education programme at a UNICEF-supported summer camp for vulnerable children in the village of Vasyshchevo, Urkraine. © UNICEF/NYHQ2005-1809/Pirozzi

education and perpetuates cycles of poverty. It is a significant barrier to progress for any nation that hopes to achieve economic growth and improved standards of living. Maternal iodine deficiency is recognized as the greatest cause of preventable mental impairment in the world. In developing countries, 38 million newborns each year are at risk of iodine deficiency.[28]

Intellectual ability is also affected by iron. The effects of iron-deficiency anaemia during infancy and the first years of life on cognitive performance are lasting. Globally, it is estimated that 47% of children under the age of five suffer from anaemia.[29] It is generally assumed that half of all anaemia cases are due to iron deficiency.[30]

Disability

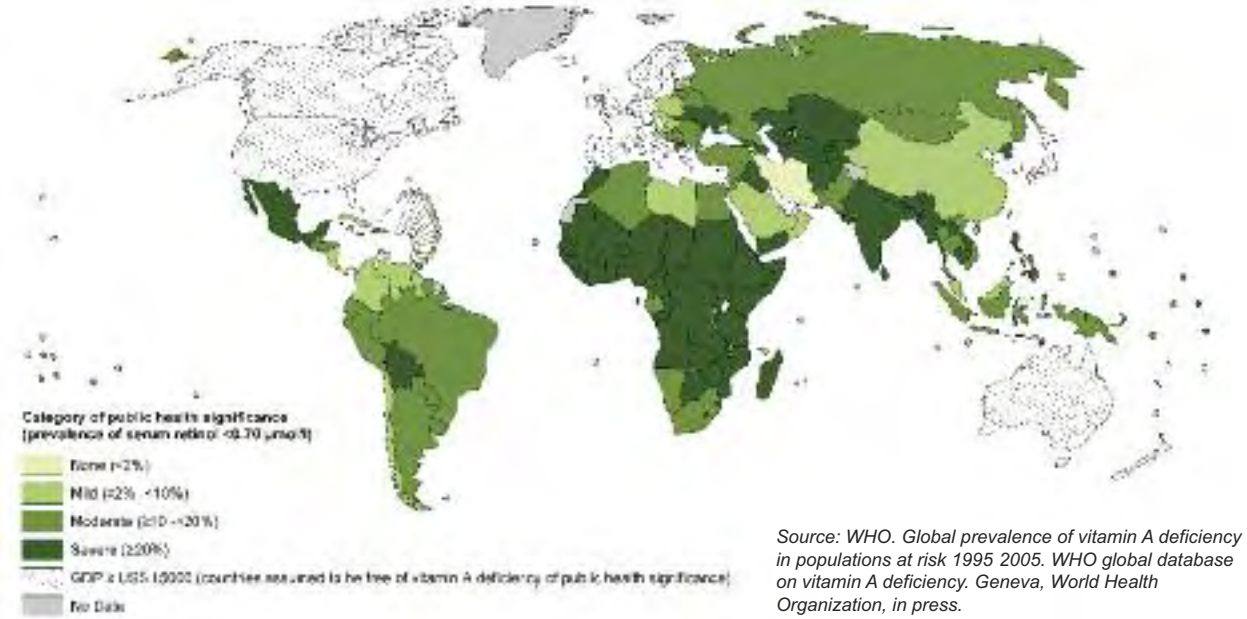
Disability can be a devastating burden for individuals and their families who lack resources. His or her options for learning and income earning are limited. In the case of severe disability, even significant resources may not be enough to enable economically productive lives. A disabled individual in a household with few resources usually experiences a greatly diminished quality of life.

Each year, spina bifida and anencephaly – the two most common types of neural tube defects – affect an estimated 300,000 newborns worldwide.[31] Severe cases of spina bifida require treatment by surgery, and even with this intervention, most affected children live with some paralysis of the legs and bowel control problems.[32] Most babies with anencephaly do not survive birth. At least half of these cases could be prevented if the mother consumes enough folic acid before and during the early stages of pregnancy.[33]

Without benefit of folic acid fortification or supplementation programmes, 150,000 babies are born every year with severe defects that are otherwise preventable.

Global Impact of Vitamin and Mineral Deficiencies[a]

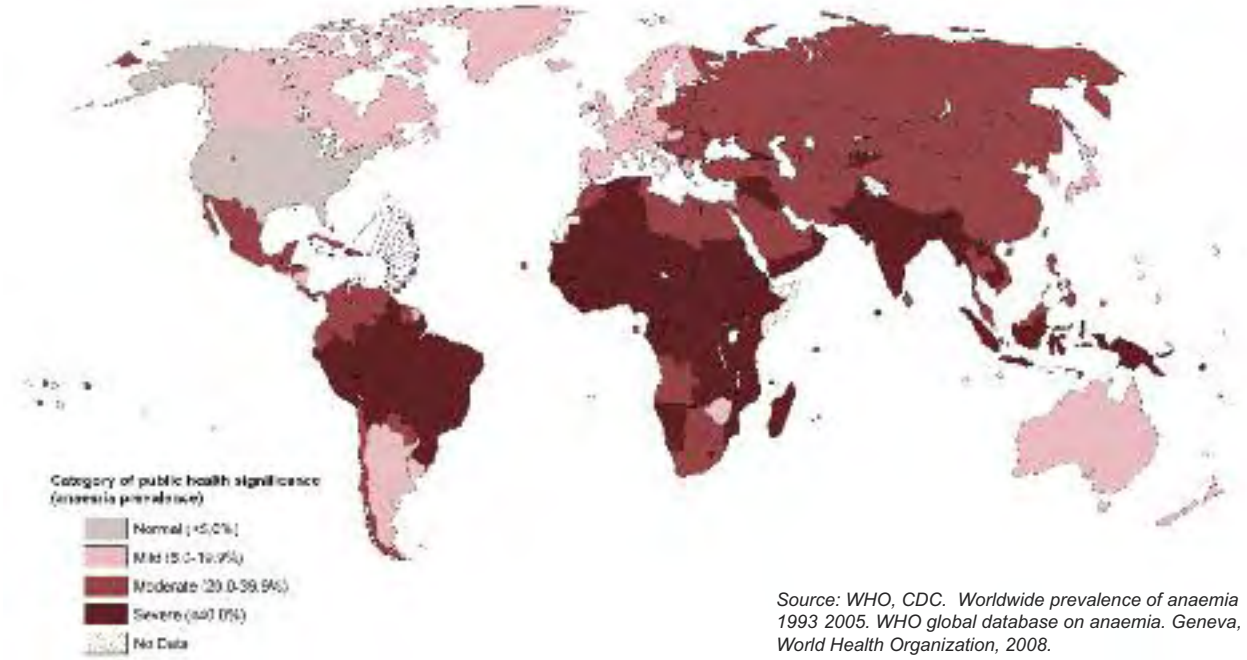
Map 1. Prevalence of vitamin A deficiency among preschool-aged children by country



Source: WHO. Global prevalence of vitamin A deficiency in populations at risk 1995 2005. WHO global database on vitamin A deficiency. Geneva, World Health Organization, in press.

As Map 1 indicates, vitamin A deficiency is a significant public health problem in more than half of all countries. Regions where vitamin A is deficient in the diet include South Asia, most of sub-Saharan Africa, some countries in Latin America, and parts of China.

Map 2. Anaemia as a public health problem by country: Preschool-aged children

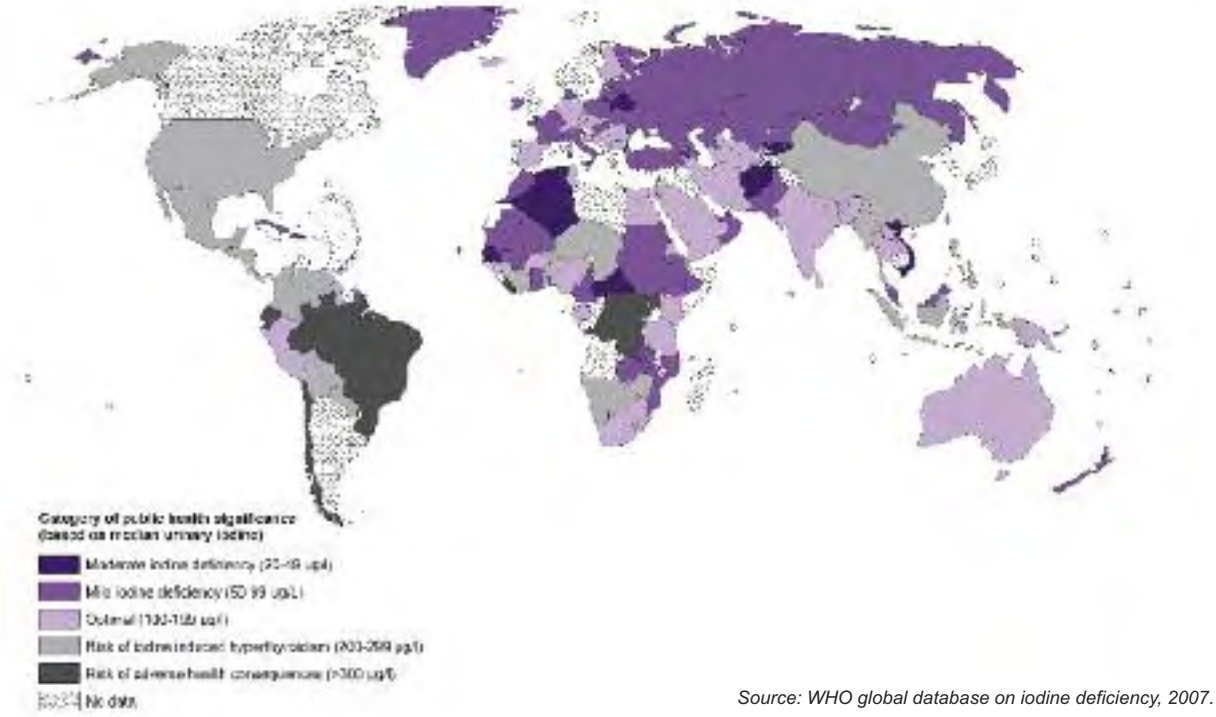


Source: WHO, CDC. Worldwide prevalence of anaemia 1993 2005. WHO global database on anaemia. Geneva, World Health Organization, 2008.

Map 2 indicates that, like vitamin A deficiency, anaemia prevalence is concentrated in sub-Saharan African, South Asia and parts of Latin America.

[a] The boundaries and names shown and the designations used on these maps do not imply the expression of any opinion whatsoever on the part of the World Health Organization, the United Nations or any other agency concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

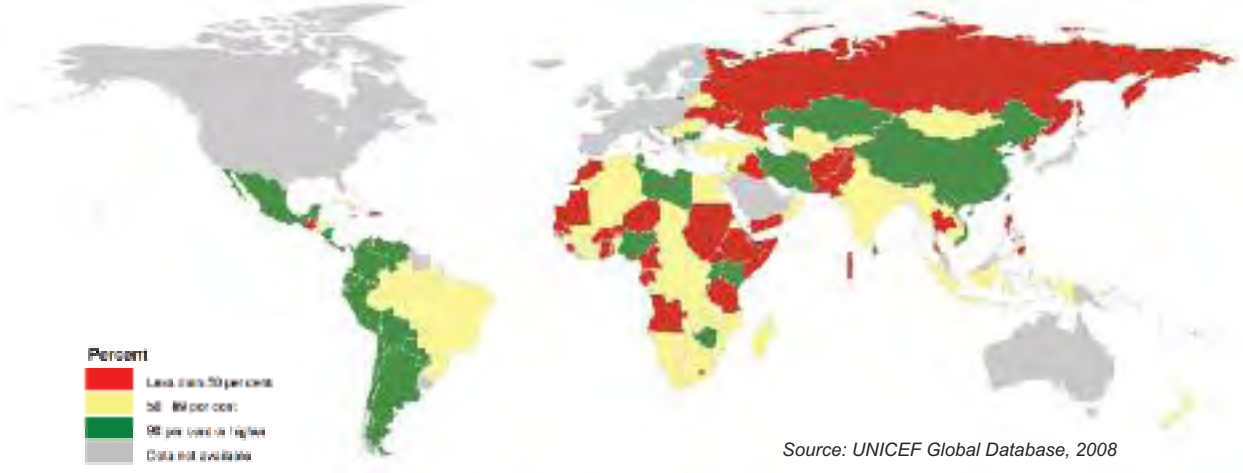
Map 3. Iodine status of school-aged children by country, based on the median urinary iodine concentration[b]



Source: WHO global database on iodine deficiency, 2007.

As Map 3 indicates, iodine deficiency remains a public health problem in approximately 45 countries. Unlike vitamin A deficiency, which is concentrated in the developing world, iodine deficiency is a problem in both developed and developing countries. In fact, Europe has the highest estimated prevalence of insufficient iodine intakes at 52%.[39]

Map 4. Percentage of households consuming adequately iodized salt (2000–2007)



Source: UNICEF Global Database, 2008

As Map 4 illustrates, 34 developing countries have achieved the universal salt iodization goal, and an additional 38 countries are considered 'on track' for elimination of iodine deficiency disorders. These are countries that have either shown increases in coverage of at least 20% over the previous decade or that have reached between 80% and 89% coverage with no indication of possible decline. Further information on progress-to-date and continuing challenges is included in Chapter 4.

[b] In generating Map 3, nationally representative data was used in the majority of cases. However, in 36 cases, sub-national data was used due to the lack of nationally representative data. For example, the estimate for India is based on data from 20 state and district surveys, representing 15 unique states.

It is estimated that 5 million children are affected by night blindness linked to vitamin A deficiency.[34] Every year, 350,000 children become blind because of this deficiency,[35] representing 70% of all new cases of childhood blindness annually.[36] These children face daunting physical, social and ultimately economic challenges.

Loss of Productivity

Every day, national economies suffer significant yet unnecessary losses in productivity due to vitamin and mineral deficiencies. In countries with the highest numbers of people living with physical and intellectual impairments, the lost potential for economic growth is staggering. Mothers tending to sick or disabled children lose days of work. Adults living with reduced energy and intelligence are unable to fully contribute to society.

As the most common and widespread nutritional disorder in the world, iron-deficiency anaemia undermines global productivity by compromising both physical and intellectual capacity. In 2006, approximately 1.62 billion people had anaemia.[37]

In China, vitamin and mineral deficiencies represent an annual GDP loss of US$ 2.5-5 billion.[38] In India, they may be costing the country US$ 2.5 billion annually – equivalent to approximately 0.4% of GDP.

Burden on Caregivers and Health Systems

Professional care for disabled children is too costly for most families, so family members dedicate themselves to this care instead of attending school or generating household income. Childhood illness – particularly when bouts are frequent and long – can lead to unaffordable costs for many families, both in terms of drug treatment and productive time lost in caring for the ill. The time and resources of health-care providers spent in the diagnosis and treatment of children who were unable to avoid disease because of vitamin and mineral deficiencies is also significant.

The Causes of Vitamin and Mineral Deficiencies

As with malnutrition in general, the causes of vitamin and mineral deficiencies are multiple and interconnected.

Poor diet

The most immediate cause is poor nutrient intake through inadequate diets. Vitamins and minerals occur naturally in food. A varied diet of meat, eggs, fish, milk, legumes, fruits and vegetables is the best basis for obtaining adequate vitamin and mineral nutrition.

While of fundamental importance, improving the diets of the world's poor is a complex and long-term undertaking that depends largely on rising incomes. In the short term, lives can be saved and improved through a range of cost-effective interventions, including supplementation and fortification.

Illness

Illness impedes the body's ability to absorb and retain vitamins and minerals. It can even lead to actual losses of them, as in the case of zinc loss during diarrhoeal illness. Vitamin and mineral nutrition is severely compromised by

A mother in Tanzania breastfeeds her two children. If exclusive breastfeeding is not practised during the first six months of life or if the solid foods introduced after that period are nutrient-poor, young children are also likely to suffer vitamin and mineral deficiencies.

parasitic infections such as hookworm. A vicious cycle ensues when the deficiencies caused by disease leave the individual more vulnerable to further illness, and less able to combat it when it strikes.

Underlying causes

Underlying poor nutrient intake and disease are issues of insufficient access to food, inadequate health care, and poor caring practices that inhibit growth and health.

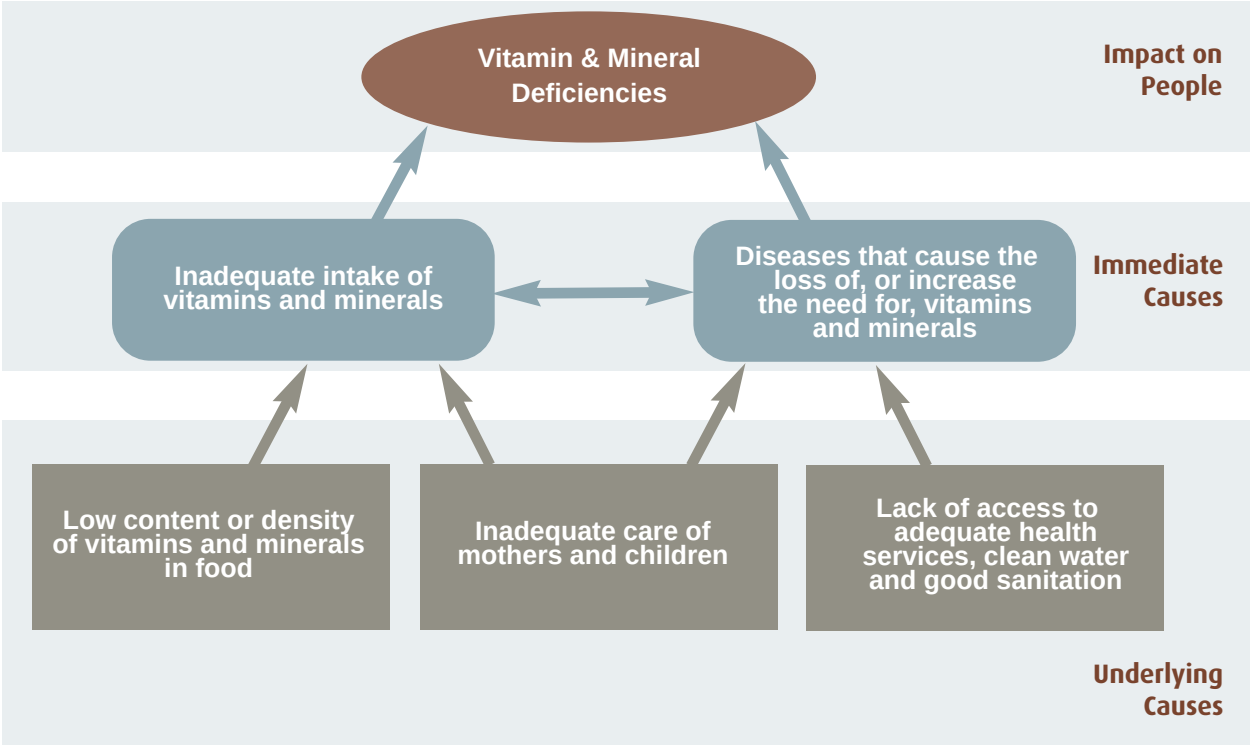
The provision of nutrition and child-care education, particularly to women, is also essential. Among the practices that would pay great dividends for children's nutritional health are:

- ensuring early and exclusive breastfeeding for the first six months of life
- providing nutrient-rich foods, in sufficient quantity and quality once complementary feeding begins
- stimulating infants and young children to encourage physical and cognitive development, and
- timely visits to health service providers for micronutrient supplementation and immunization.

Unfortunately, support for household nutrition and child-care remains out of reach for those who have limited access to health services. Despite the many causes of vitamin and mineral deficiencies and the great challenge posed by the sheer numbers of people affected by them, highly cost-effective solutions exist.

In 2003 it was estimated that without appropriate interventions, India's productivity losses due to undernutrition, iron deficiency anaemia, and iodine deficiency disorders could equal US$ 114 billion between 2003 and 2012.

Figure 2. The main causes of vitamin and mineral deficiencies



Source: Adapted from Determinants of Malnutrition: The State of the World's Children, UNICEF, 1998

Refugees and those affected by emergencies are especially vulnerable to vitamin and mineral deficiencies

A Sudanese refugee seeks shelter from a sandstorm near Tine, Chad. Vitamin and mineral deficiencies can easily develop during an emergency (such as war or a natural disaster). © UNHCR/H.Caux

Vitamin and mineral deficiencies can easily develop during an emergency – or worsen if they are already present.

In times of war or natural disaster, livelihoods and food crops are lost, food supplies are interrupted, diarrhoeal diseases break out, and infectious diseases suppress the appetite while increasing the need for micronutrients to help fight illness.

Vitamin and mineral deficiencies have been reported for years in emergency settings, especially in refugee camps. For instance, a 2003 study among Burmese refugees in Thailand found that 65% of children suffered iron-deficiency anaemia.

Due to a variety of factors, the delivery of essential micronutrient interventions is especially challenging in emergency settings. Although vitamin A supplements are already routinely included as part of an emergency response, other deficiencies are too often neglected.

However, during the past decade, multiple micronutrient fortification has been used increasingly in these situations. In 2003, mobile milling and fortification equipment was used at the Nangweshi refugee camp in Zambia to fortify maize meal with a number of micronutrients, including vitamin A, folic acid, iron and zinc. A 2007 study found that the introduction of fortified maize meal led to a decrease in anaemia in children and a decrease in vitamin A deficiency in adolescents.

The UN Standing Committee on Nutrition has suggested that a combination of interventions may be appropriate, including increased access to fresh food, improved livelihoods and access to markets, enhanced fortification of food aid, distribution of supplements, and in-home fortification with multiple micronutrient powders or fortified condiments.[41]

4 Investments in Human Capital

This chapter looks at the past, present, and potential for a variety of micronutrient interventions including:

- ✔ vitamin A supplementation
- ✔ salt iodization
- ✔ food fortification – flour, rice, oil, sugar, fish and soy sauce, and complementary foods
- ✔ multiple micronutrient solutions
- ✔ zinc supplementation for diarrhoea management

WHILE SUPPLEMENTATION AND FOOD FORTIFICATION with vitamins and minerals had been taking place in industrialized countries for decades, it was not until the mid-1980s that public health researchers and programme implementers began to turn their attention to micronutrients as tools for achieving health and development at the global level.

Today, the array of available micronutrient interventions offers some of the most proven along with some of the most quickly emerging opportunities for improving the health and intellectual capacity of nations.

The Essential Role of Partnerships

Delivering vitamins and minerals to large populations involves commitment, coordination and cooperation – all held together by strong and durable partnerships. Key partners in micronutrient interventions include national governments, donors, aid agencies, foundations, industry, community leaders, and the agricultural sector.

For example, in the mid-1990s, **vitamin A** supplementation programmes began a rapid expansion under the leadership of national governments in many of the countries that were most affected. The governments were supported by organizations such as UNICEF, WHO, donor governments, and both international and local civil society organizations. These partnerships became models for successful large-scale programme implementation.

The story of **salt iodization** in developing countries is one where the private sector has come to play an especially strong role, working in close partnership with national governments as well as with other development partners. Building on the initial capital and other investments provided by international donors and groups such as Kiwanis, most of the salt industry and their consumers are already absorbing the minimal additional costs of iodization. National governments, agencies, civil society and other partners are also now working with processors of all sizes to enable them to iodize their salt, so as to complete universal coverage.

Food fortification relies on strong partnerships between the public, private and civic sectors. Governments have a role to play by enacting and enforcing legislation and reducing tariffs and duties on imported fortification premixes. Technical experts research the best ways of fortifying foods to benefit the largest numbers of people. Industries contribute marketing, business and technical expertise to promote fortified foods to consumers. Informed consumers and the media spread the word, and help to stimulate sustained popular demand for fortified foods.

Government ministries of health and researchers play a key role in interpreting the evidence on beneficial new initiatives such as **multiple micronutrient powders** and **zinc supplementation**, and then acting to enable and promote their introduction and scale-up. Private sector

Dora, 3, receives a dose of vitamin A outside a mobile health clinic in Namurava village in Mozambique. The clinic provides a range of maternal and child health services, including vaccination, vitamin A supplementation, growth monitoring, deworming, and diagnosis and treatment of readily identifiable illnesses. © UNICEF/NYHQ2006-2237/Pirozzi

manufacturers play a very critical role by acting to respond to the emerging demand for such new products, as do regulatory bodies in assuring their quality. Health professionals, civil society and medical associations all need to work together to help raise people's awareness of the benefits. Donors and other development partners can contribute technical expertise and other support to help expand programmes in a cost-effective manner.

Vitamin A Supplementation

Vitamin A supplementation is one of the most effective large-scale child survival interventions. Since the mid 1990s the push has been on – with generous support and leadership from the Government of Canada through the Canadian International Development Agency (CIDA) and the United States Agency for International Development (USAID) – to provide two annual doses of vitamin A to children aged six months to five years in many countries with high mortality rates.

What it is and how it works

Supplementation of children with vitamin A entails snipping off the end of a small high-dose vitamin A capsule and emptying the liquid contents into the mouth of a child, or administering a small amount of syrup solution to the child. Two annual high-dose supplements are all that is required to provide the recommended amount of vitamin A to a child.

Administering vitamin A is a simple act that can be performed by a trained health worker, community worker or volunteer. The great challenge over the next few years is to reach every child with this life-saving intervention regularly twice a year, and to sustain universal coverage for as long as is needed.

Routine visits by children to health centres provide an opportunity for supplementation. But experience has shown that too many barriers exist to make this the primary approach for achieving high coverage. Even when health-

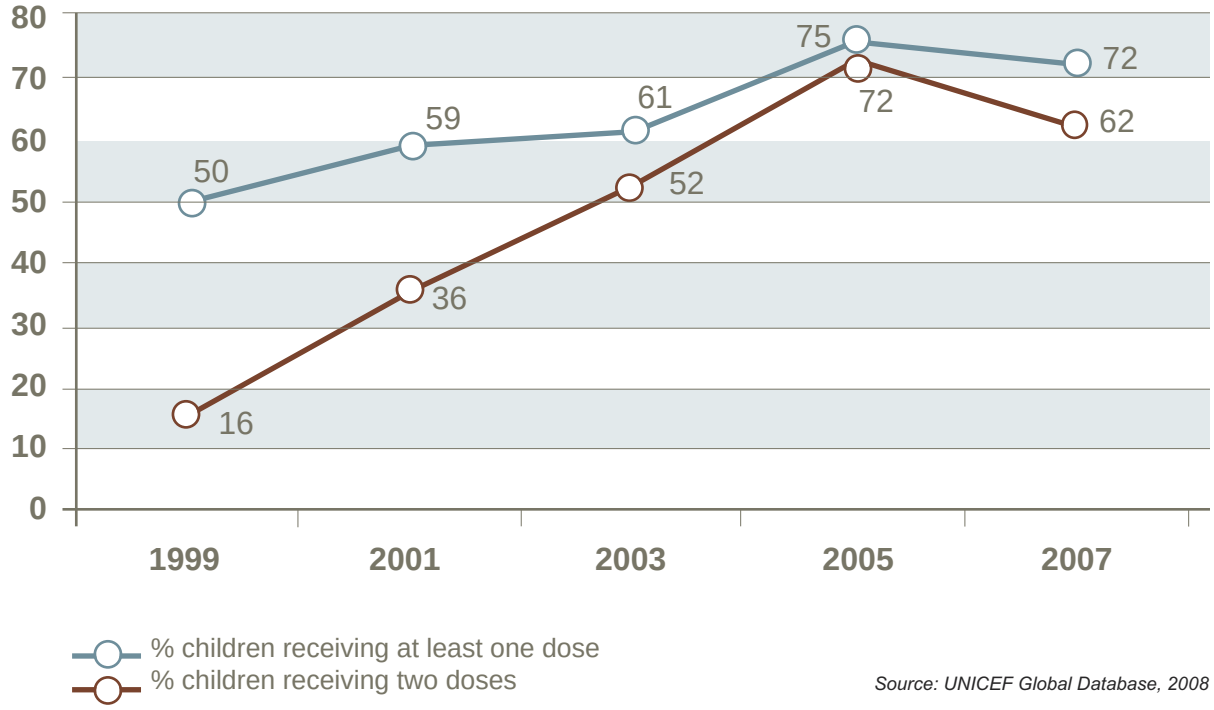
Zambia's Child Health Weeks – delivering vitamin A supplementation through the health system

Child Health Weeks (CHW) provide an effective opportunity to deliver a core set of services for child survival through the existing health system. Since 2000 the Government of Zambia, with the financial and technical support of UNICEF, has been organizing semi-annual CHWs.

During five-day periods in June and December, parents are encouraged to bring their children to local health facilities, which provide vitamin A supplements, routine immunizations, deworming, growth monitoring and promotion, and malaria control services.

An impact assessment conducted in 2003 showed that 95% of mothers had heard of CHWs and 89% of mothers had taken their child to the last CHW.[42] According to the assessment, 77% of children received vitamin A and 71% were also dewormed. The assessment also showed that severe vitamin A deficiency was halved compared to the level found before the CHWs, and that anaemia in children under five was reduced from 65% to 53%.

Figure 3. Progress with vitamin A supplementation for children aged 6–59 months



Source: UNICEF Global Database, 2008

care centres are accessible, many parents discontinue semi-annual visits beyond their child's second birthday once their scheduled vaccinations are completed.

Given these challenges, campaign-style health events initially proved to be the most effective method of reaching the greatest numbers of children with their required doses of vitamin A. Ministries of health, international organizations and volunteers were mobilized around events such as National Immunization Days to deliver immunizations and vitamin A supplements together.

More recently, Child Health Days or Weeks, with numerous interventions delivered during the same event, have attracted great participation and reached large numbers of children. Depending on local needs, these events can include immunizations, bed nets, deworming tablets, growth monitoring, salt testing for the presence of iodine, and vitamin A supplementation.

Progress to date

In 2007, it was estimated that 62% of children under the age of five in developing countries received two high-dose vitamin A supplements.[43]

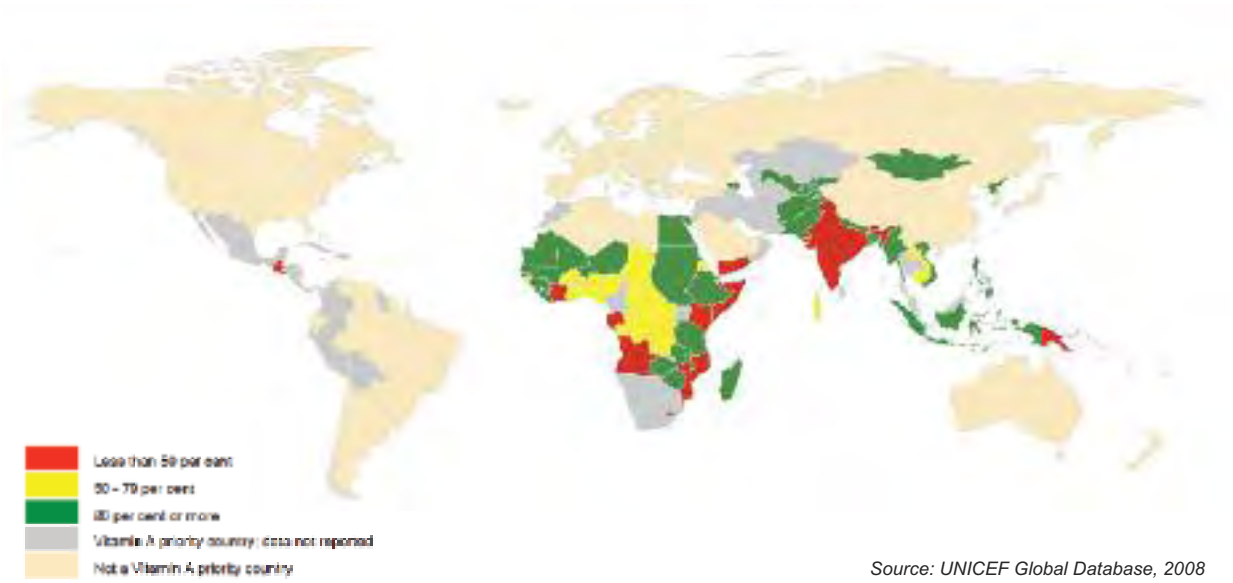
When political will and international financial resources have been available, even resource-poor nations have been able to reach the majority of their populations. The least developed countries of the world, as categorized by UNICEF, achieved approximately 82% coverage by 2007 with two doses and 84% coverage with one dose.[44] High coverage needs to be maintained over several rounds to achieve health impact.

Global efforts have targeted 103 UNICEF-priority countries,[45] and rapid progress over time in these countries has been particularly impressive. As Figure 3 indicates, in 1999, just 16% of children in these countries received full vitamin A supplementation. By 2007, that number had more than quadrupled to 72%.[46] In 2007, the rate of coverage dropped to 62%. This is partly because India increased its target group from three to five years of age. Also, more reliable resourcing is needed to maintain at least a base of twice-yearly coverage.

However, while these figures show what progress is possible when effective strategies, political will and sufficient resources are applied, significant gaps in vitamin A supplementation coverage remain and continue to undermine children's health.

In 2004, only one quarter of UNICEF's 103 priority countries had reached the 70% coverage threshold, at which point they could begin to see significant reductions in child mortality.[47] Worldwide, approximately 190 million children remain affected by vitamin A deficiency.[48]

Map 5. Vitamin A supplementation coverage levels: two doses (2007)[c]



Source: UNICEF Global Database, 2008

The hardest-to-reach children are typically those who would benefit most from vitamin A supplementation. Special outreach programmes may be required to reach them.

The hardest-to-reach children are typically those who would benefit most from vitamin A supplementation. They usually have poor access to nutrient-rich foods and health services, and their mothers often lack knowledge of certain critical childcare practices. It is vital that these children stay in the sights of governments and the international community.

What more needs to be done

Priority actions include the need to:

- ✔ Scale up the delivery of integrated package of health services, including twice yearly vitamin A supplementation for children aged between 6 months and five years, to achieve at least 80% coverage on recurrent basis.
- ✔ Target the hard-to-reach through complementary strategies, such as special outreach programmes, to reach the final 20% who have not be reached through regular programmes.
- ✔ Improve programme sustainability by mobilizing resources in national budgets to cover costs pertaining to vitamin A supply and local distribution.
- ✔ Establish integrated delivery strategies, monitoring of programmes, and tracking of progress.

Children in Bangladesh. Vitamin A supplements can reduce under-five mortality rates by an average of 23%. © MI

[c] *The boundaries shown and the designations used on these maps do not imply official endorsement or acceptance by the United Nations or any other agency.*

Salt Iodization

The greatest story of progress in food fortification has been that of salt iodization, demonstrating how well government commitment, market opportunity and social responsibility can be combined for improved health.

With iodization initiatives dating back to the early years of the 20th century in the industrialized world and more than two decades of expansion in developing countries, the technology for large-scale salt iodization has been long proven. Models of legislative frameworks, industrial standards, shipping and handling guidelines, monitoring systems and social marketing campaigns all exist to guide the way for achieving universal salt iodization.

The sustainable elimination of iodine deficiency disorders is within the world's grasp. When it is achieved, it will be a major public health triumph, eliminating the primary cause of preventable mental retardation in the world.

What it is and how it works

Salt is consumed throughout the world in small, fairly consistent amounts on a daily basis. Because of this, it is an ideal vehicle for fortification with micronutrients. In most countries, potassium iodate is added to salt after it is refined and dried and before it is packed. There are numerous methods of adding the compound to the salt. The most appropriate method depends on the quality of the salt, and on local conditions and resources. The amount of iodine added to salt can be varied to suit local consumption patterns – allowing changing diets to be taken into account.

Packaging and storage are important to the quality of the iodized salt because humidity and temperature affect the retention of the iodine in the salt. Like most industrial procedures, large-scale salt iodization is the most efficient. However, even very small-scale iodization at the village level is possible with tried-and-tested processes, and in some countries, small processers are the ones producing the majority of the salt.

Progress to date

Between 1993 and 2007, the number of countries in which iodine deficiency disorders were a public health concern reduced by more than half – from 110 countries to 47.[49] These striking public health results are clearly linked to expanded salt iodization. In 1990, less than 20% of households in the developing world were consuming iodized salt.[50] Today that figure has increased to 70%.[51]

Thirty-four developing countries have achieved the universal salt iodization goal,[52] and an additional 38 countries[53] are considered 'on track' for elimination of iodine deficiency disorders. These are countries that have either shown increases in coverage of at least 20% over the previous decade or that have reached between 80% and 89% coverage with no indication of possible decline.[54]

Despite this progress, many countries are lagging far behind. Twenty-four countries have experienced no growth in coverage rates or have even experienced a decline since the mid 1990s.[55] In 12 countries, less than 20% of the population is consuming adequately iodized salt.[56] Around the world, approximately 38 million children are born every year unprotected against the risk of iodine deficiency.

What more needs to be done

Priority actions include the need to:

- ✔ Enact mandatory legislation and ensure adequate resources are made available to enforce it.
- ✔ Build financial sustainability to transition from a donor-supported to a market-supported supply of iodate.
- ✔ Undertake strategic advocacy and communication efforts through media, health systems, and schools.
- ✔ Strengthen population monitoring systems so that programme adjustments can be made as habits and diets change over time.
- ✔ Create incentives for processors to iodize their salt.

Food Fortification

Fortification is the process of adding vitamins and/or minerals to foods to increase their overall nutritional content. In addition to salt, numerous staple foods present tremendous opportunities for providing micronutrients to large populations. Currently, wheat flour, maize flour and rice, cooking staples such as sugar and oil, processed foods such as biscuits, and condiments such as soy and fish sauces are being used around the world as vehicles to improve vitamin and mineral health.

The most appropriate foods will depend on:

- the quantity of the food eaten by the target population

A salt processor shovels salt that has been iodized using a mobile machine on the shore of Senegal's Lac Rose. More than one third of Senegal's salt is produced by tens of thousands of small-scale harvesters, presenting a challenge for iodization programmes. © MI

Small-scale processors key to achieving Universal Salt Iodization

Senegal is the largest producer and trader of salt in West Africa. An estimated third of its annual yield, 150,000 metric tonnes, is produced by small-scale salt harvesters and processors who supply both local markets and neighbouring countries. While iodization laws have been in place in the country for years, adequately iodizing this salt has proven difficult. In 2006, potassium iodate was not available at 63% of the salt production sites and 71% of salt iodization machines were out of service.

To overcome these challenges, producers, organized in small cooperatives called groupements d'intérêt économique (GIEs), were provided with improved salt iodization machines, internal quality assurance and production tools, and appropriate training on their use. A revolving loan fund was established among the producers to assure a steady supply of potassium iodate and provide funds for the GIEs. These programmes are undertaken in partnership with the Senegalese government's Cellule de lutte contre la Malnutrition, UNICEF, the World Food Programme, and the Micronutrient Initiative.

Production trends and informal discussions with producers have indicated increased commitment and compliance of producers and distributors with salt iodization regulations. GIEs are able to use the revolving fund to pay for regular repairs by local mechanics, ensuring the continued functioning of the iodization units, and to purchase adequate amount of iodate. In 2007–8, the GIEs were producing more than 83,000 metric tonnes of adequately iodized salt.

- the effects of the fortification process on factors such as colour and taste, and
- the effects of the fortification process on product price.

Flour Fortification

What it is and how it works

With more than 647 million tons of wheat produced annually on a global level,[57] it is not surprising that wheat flour is the most consumed cereal flour in the world.[58] For more than 60 years, flour fortification has proven effective in the reduction of vitamin and mineral deficiencies.

Flour fortification provides a platform to increase folic acid, iron, zinc, and other B vitamins in the diet of the population. Regular consumption of bread, noodles and other flour products fortified with such micronutrients can contribute to improving a deficient diet. In general, flour fortification is technically simple, requiring only minor modifications in most modern flour mills.

Progress to date

Flour fortification expanded worldwide between 2004 and 2007. Thanks to an increase in wheat flour fortification from 18% in 2004 to 27% in 2007, the number of people with access to fortified wheat flour increased by approximately 540 million during that period.[59] This included 14 million newborns whose mothers had access for the first time to fortified flour while pregnant.[60]

By 2009, 30% of the world's flour produced in large roller mills was being fortified.[61] Flour fortification with iron, folic acid and, in some cases, other nutrients was taking place in

Women shop for bread at a market in Chuquisaca, Bolivia. Bolivia passed a law in 1996 to require its wheat flour to be fortified with iron, thiamine, niacin, riboflavin and folic acid. © Alexandra Dionyssia Huttinger

Britannia, Naandi and GAIN – A public-private partnership for delivering nutrition through fortification in India

Multi-sectoral partnerships foster the development and distribution of appropriate micronutrient-rich foods by combining the know-how and expertise of various stakeholders, and have been used in the production of staple foods and products targeted at vulnerable groups.

In India, iron-fortified biscuits for school-aged children were developed and distributed via a partnership between Britannia Industries, the Naandi Foundation and the Global Alliance for Improved Nutrition (GAIN). Biscuits were identified as a suitable vehicle for vulnerable populations as more than 50% of biscuits in India are consumed in rural areas.

GAIN provided technical advice and financing during the development and piloting of the fortified biscuits. Naandi distributed the biscuits to school-aged children via their midday-meals programme. Following the success of these biscuits in schools, Britannia began distribution of fortified biscuits throughout India. It is estimated that two billion packets of Britannia's iron-fortified biscuits are now sold per annum in India.

Automated feeders at a flour mill. Flour fortification takes place at mills where a premix of vitamins and minerals is added along with other ingredients to improve the quality of flour. © Seaboard Corporation

at least 63 countries.[62] Fifty-six of these had developed national standards for fortification of wheat flour. Although these numbers demonstrate progress, the 70% of unfortified flour represents an opportunity to improve public health for hundreds of millions of people.

While fortification of flour with folic acid is relatively new, public health results are already demonstrating the future potential of expanded fortification.

Thanks to an increase in wheat flour fortification from 18% in 2004 to 27% in 2007, the number of people with access to fortified wheat flour increased by approximately 540 million during that period.

In the United States, Canada, Chile, and South Africa, studies have shown great reductions in numbers of children born with a neural tube defect since nationally mandated flour fortification with folic acid came into effect in the late 1990s. Rates have dropped by 26% in the United States, 42% in Canada, 40% in Chile, and 30% in South Africa.[64]

What more needs to be done

Priority actions include the need to:

- ✔ Set and monitor national standards for flour fortification and ensure standards are enforceable, so that all millers have equal financial obligations.
- ✔ Identify and train fortification champions from both the public and the private sectors to build on success to date and help rapidly expand fortification efforts.
- ✔ Launch communication and public education initiatives to create a market demand for products and support for government investment.

South Africa's national fortification programme successful in reducing birth defects

In 2003, South Africa launched its national Food Fortification Programme. It required any manufacturer of bread wheat flour or maize meal to fortify these staples with eight micronutrients including vitamin A, folic acid, iron and zinc.[65]

Partnerships with international organizations such as GAIN, the Micronutrient Initiative (MI) and UNICEF were formed to support social marketing and monitoring of compliance and quality. The South African government subsidized millers for the purchase and installation of fortification equipment.

A 2007 study found a significant decline in birth defects resulting from the fortification programme, with reductions in spina bifida and anencephaly by 41.6% and 10.9%, respectively.[66] A separate study found a 66% reduction in perinatal deaths related to neural tube defects, and a 39% reduction in NTD-related infant mortality.

The decrease in birth defects found in South Africa is consistent with decreases observed in other countries that have fortified their food supplies.

By comparing the cost of fortification against the cost of treating birth defects avoided by fortification, there was a benefit:cost ratio of approximately 30:1, again indicating that micronutrient fortification is one of the most cost-effective public health interventions available.

Other Foods to Fortify

Each country should analyze the dietary habits and micronutrient status of its citizens in order to determine the best fortification options for investment. In most cases, the fortification of multiple foods will ensure the best coverage of the population. It is important to develop programmes that increase consumption of fortified foods by the poor and most vulnerable citizens. This requires ensuring appropriate pricing and marketing and communication activities that target this segment of the population.

Rice. A staple food for more than half the world's population, rice is a logical food for fortification.[67] It is the main staple food in 15 countries in Asia and the Pacific, 10 countries in Latin America and the Caribbean, seven countries in sub-Saharan Africa and one country in North Africa.[68] Fortificants include vitamins A and E, vitamin B-1, niacin, folic acid, vitamin B-12, zinc, iron, and selenium.[69]

Edible oil. Oil is an ideal food for vitamin A fortification because it assists the body in absorbing the vitamin. Additionally, since the oil-soluble form of vitamin A is not only easily added to oil but is also the cheapest form available, the fortification process is relatively inexpensive. While oil fortification is not yet widespread, promising models of food companies adopting the practice offer a significant opportunity for expansion, as in West Africa where a regional initiative has been launched.

Sugar. The technology for fortifying sugar was developed in Guatemala in the mid-1970s, and the country has been the leader in the practice, first with vitamin A and then with both vitamin A and iron. Sugar fortified with vitamin A, iron, and zinc, either alone or in any combination, is commercially available in Brazil.

Fish sauce. In Viet Nam, fish sauce has been singled out as the best opportunity to reach great numbers with iron fortification. At least 80% of the population consumes fish sauce regularly.[70] Studies have shown significant improvement in iron status of the population after the introduction of fortified fish sauce.[71]

Soy sauce. In China, soy sauce is a condiment consumed by 80% of the population, making it the primary product of choice for iron fortification in that country since 2002.[72] After two years of investment on the part of the Chinese Center for Disease Control and Prevention in partnership with private manufacturers and GAIN, an estimated 58.6 million people out of a total population of 300 million in seven pilot provinces and Beijing were using iron-fortified soy sauce.[73]

A Kenyan mother and child with a bottle of edible oil that has been fortified with vitamin A. While oil fortification is not yet widespread, promising models of food companies adopting the practice offer a significant opportunity for expansion. © MI

Fortified complementary foods. The first 1,000 days of a child's life are critical for long-term mental and physical development. The importance of complementary foods that contain necessary vitamins and minerals in the 6-24 month period of life is a focus of programmes to reduce vitamin and mineral deficiencies. In order for complementary foods to have the desired impact, innovative, socio-culturally appropriate methods are being developed to improve the quality of foods commonly given to this age group. This includes promoting beneficial feeding behaviors as well as identifying the best way to ensure the foods eaten contain adequate vitamins and mineral for this age group. In order to help achieve adequate consumption of vitamins and minerals, home based fortification of foods as well as community and mass-produced complementary foods are new areas for micronutrient research and programming.

Two women employed at an Anganwadi Centre in South 24 Parnagas District, West Bengal, hold a packet of Vita-Shakti, a bulk multiple micronutrient powder that is added to the Centre's daily meal. © MI

Multiple Micronutrient Solutions for Children

What they are and how they work

Home-based multiple micronutrient supplements developed to date have primarily taken the form of powders to be added to food just before it is eaten. They provide easy-to-use, practical solutions to mothers and caregivers who are interested in improving the vitamin and mineral health of their children. They typically come in small packets, each with adequate powder for one serving. Current formulations for in-home use include a range of vitamins and minerals including iron, vitamin A, folic acid, zinc and sometimes vitamin C.

Development of the first powders took place at The Hospital for Sick Children in Toronto, Canada in the late 1990s. The resulting product, called Sprinkles, was originally designed for children between six and 24 months, but formulations have since been developed for older children, adolescents, and pregnant and lactating women.

With the support of international development agencies, country-specific products such as Chispitas, Anuka and BabyFer have been developed and distributed in diverse countries including Bolivia, India and Haiti. Studies assessing the positive health benefits of Sprinkles in Bangladesh showed significant declines in anaemia rates. The household-level consumption of 60 sachets over 120 days reduced the prevalence of anaemia from 72% to 30%.[74]

The first steps of distribution include officially registering the products nationally and procuring and shipping them to distribution points. In some cases, distribution to households has taken place through national health plans targeting mothers and children, with the support of international organizations. A key component of programming has been promotion of the product to both health professionals and the end-users. In the case of BabyFer in Haiti, the micronutrient sachets were sold through commercial channels.

Progress to date

Thus far, large-scale distribution has been limited to a small number of countries. However, early results show great promise. In 2007, the Government of Bolivia became the first to provide free public distribution of multiple micronutrient powders on a national scale and reached approximately 750,000 young children.[76]

In Haiti, BabyFer achieved sales of approximately US$ 1.2 million in 2006. While this was a good start, it represented coverage of the equivalent of only 5% of all Haitian children six to 24 months with the recommended annual dose.[77]

Sprinkles – reducing anaemia in Mongolia

To address the high prevalence of anaemia in Mongolian children aged six to 35 months, World Vision, in collaboration with the Mongolian Ministry of Health and The Hospital for Sick Children in Toronto, designed and implemented an integrated nutrition programme. The backbone of the programme was the distribution of Sprinkles home-based fortification sachets (including both iron and vitamin D).

Between 2001 and 2003, Sprinkles were successfully distributed by World Vision field staff to over 15,000 children in seven districts. Coverage was over 80%, at a cost of about US$ 0.03 per sachet. In the project area, the prevalence of anaemia decreased from 42% to 24%.[75] The programme has since been scaled up throughout the country.

A community health volunteer gives Sushmita Sumbhamphe, who is nine months pregnant, vitamin A, iron and folic acid supplements, during a home visit in the remote, mountainous eastern region of Nepal.
© UNICEF/NYHQ2007-1493/Khemka

What more needs to be done

Priority actions include the need to:

- ✔ Scale up availability of multiple micronutrient supplements for in-home use, such as Sprinkles, in non-malaria endemic regions.
- ✔ Direct research efforts to find safe and cost-effective ways to improve iron intake by young children in malarial areas.

Supplements for Women of Child-bearing Age

What it is and how it works

Since micronutrient intake is critical from the point of conception, it is important to reach not just pregnant women with multiple micronutrient supplements, but all women of child-bearing age.

Iron and folic acid are the focus of most current supplementation programmes. This is due both to the particularly harmful effects of anaemia and folate deficiency for babies and mothers, and to increasing evidence of efficacy of these supplementation programmes. Many

supplementation programmes are reaching women through antenatal clinics. Others are achieving success by means of community volunteers. In some countries, outreach is taking place through community organizations, as well as businesses that employ great numbers of women.

Through these programmes, women are educated about the benefits of supplementation and provided access to them. Supplements may be available for sale – often the case for non-pregnant women – through local drug stores or village health workers. Some programmes are providing the supplements free of charge to pregnant women through antenatal clinics. In most cases, supplements are to be taken once a week, but some programmes include daily supplements during pregnancy.

Progress to date

Iron-folic acid supplementation is a traditional component of antenatal care that is frequently undervalued. A large-scale weekly supplementation programme in Cambodia, the Philippines and Viet Nam, targeting 90,000 women, resulted in eliminating iron-deficiency anaemia and iron deficiency among participating women during their first and second trimesters.[80]

A community-based programme in Nepal that prioritized the participation of female community health volunteers increased supplementation coverage from 23% to 59% in five years.[81]

What more needs to be done

Priority actions include the need to:

- ✔ Expand and scale up iron and folic acid supplementation for all women of child-bearing age, with special focus on pregnant women.
- ✔ Bring increased focus on improving adherence rates, through community outreach, counselling, and related efforts.
- ✔ Explore the feasibility of providing women with multiple vitamin and mineral supplements.

Nepal drastically reduces the prevalence of anaemia in pregnant women from 75% to 42%

In 1998, anaemia among pregnant women in Nepal was alarmingly high at 75%, and coverage of iron–folic acid supplementation was low.[78]

The National Anaemia Control Strategy and Iron Intensification Programme was developed in 2003 to increase the coverage and compliance of iron supplementation along with complementary measures such as deworming of pregnant women and dietary diversification, food fortification, and promotion of maternal care practices. The Government of Nepal started the programme with five districts in 2003 and has expanded to 46 districts as of 2007 with support from the Micronutrient Initiative, UNICEF and WHO. The Government aims to cover all 75 districts by 2010.

To improve access, female community health volunteers were trained to distribute the iron supplements. A strong monitoring system was put in place by using community-level micronutrient registers to track pregnant women. In five districts, a school-based monitoring system was also piloted, whereby school children were mobilized to ensure early identification of pregnant women.

According to the Demographic Health Survey in 2006, the national coverage of iron supplementation has increased from 23% to 59%. Because of these improvements and other complementary measures, anaemia in pregnant women has been reduced from 75% to 42%.[79]

Zinc Supplementation for Diarrhoea Management

What it is and how it works

The use of zinc supplements, in addition to oral rehydration, is a relatively new and extremely powerful method for reducing diarrhoeal disease – a particularly serious illness among children under five years of age.

By quickly rehydrating the child whose body rapidly loses dangerous amounts of fluid during a diarrhoeal episode, death from diarrhoea can be averted. Though survival is key, it is equally important to help the affected child combat and recover from the illness. Zinc has recently proven itself to be the most effective weapon in this fight.

In 2004, the World Health Organization and UNICEF formulated a new recommendation to administer zinc for 10 to 14 days as an adjunct treatment for diarrhoea, along with low-osmolarity oral rehydration solutions (ORS) and

continuation of feeding. Supplemental zinc is provided in tablet or syrup form and may be distributed in a number of ways:

- through a doctor or health worker, who prescribes and perhaps even provides a pack of tablets with ORS with guidance
- through a pharmacist, patent medicine vendor, or community drug distributor who sells a strip of zinc tablets or syrup, and ORS with guidance
- through attendance at a child health day, where parents receive one or more packs of ORS sachets plus a strip of zinc supplements with guidance for their use the next time one of their children gets diarrhoea, or
- through attendance at a child health day, where parents receive a voucher that can be redeemed at a pharmacist for a pack of zinc plus ORS with guidance.

A study in India in 2008 demonstrated that adding zinc to ORS treatment resulted in diarrhoea being treated much more often (60%) than when treatment comprised ORS alone (10%).

Studies in India and Pakistan showed that zinc supplementation resulted in a decrease in payments by households for medicine and consultation fees of more than US$ 1.00 per patient per episode.[82] With nearly four billion new cases of diarrhoea each year[83] and global ORS coverage at only 38%,[84] the incorporation of zinc supplementation into diarrhoeal treatment offers an opportunity for health systems to reinvigorate diarrhoeal management programmes.

Progress to date

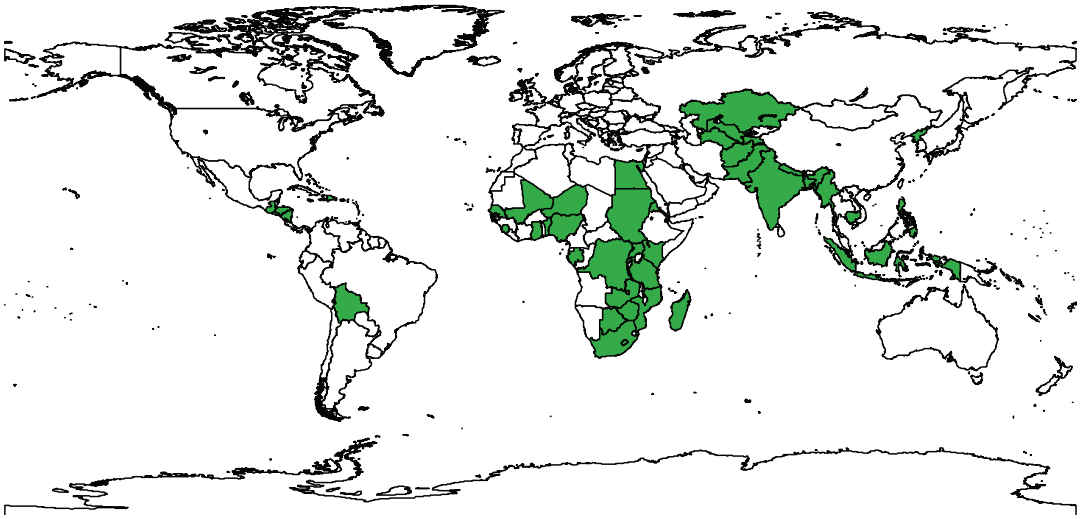
Following the joint statement in 2004 by the World Health Organization and UNICEF recommending the use of zinc in the management of diarrhoea,[85] these organizations, along with USAID and Johns Hopkins University, began work to ensure the availability of zinc products.

The following year, through collaboration with the United States Pharmacopoeia, guidelines were in place for pharmaceutical manufacturers.[86] At the same time, UNICEF worked to identify suppliers of zinc products. UNICEF procurement started in 2006 and by late in 2008 had increased from 20 million tablets to 91 million tablets.[87]

A young Guatemalan boy receives a full course of zinc tablets for diarrhoea treatment. The use of zinc supplements in addition to oral rehydration is a relatively new and extremely powerful method for reducing diarrhoeal disease – a particularly serious illness among children under five years of age.© MI

Despite the significant increase, this represents only 13 million treatments.[88] As Map 6 indicates, since the new recommendations were made in 2004, only 46 countries have adopted zinc policy as part of their national child health policy.[89]

Map 6. Countries that have adopted national policy on zinc supplementation



Countries that have adopted zinc policy as part of their national child health policy

Source: Zinc Task Force, using data from UNICEF, USAID and WHO.

What more needs to be done

Priority actions include the need to:

- ✔ Incorporate zinc supplementation into national diarrhoea management policy.
- ✔ Ensure zinc supply.
- ✔ Identify public and private delivery strategies.
- ✔ Create demand through social marketing campaigns.
- ✔ Provide adequate financing for start-up.

Successful zinc supplementation scale-up in Nepal

According to the 2006 Nepal Demographic and Health Survey (NDHS), diarrhoea continues to be a major cause of childhood morbidity and mortality in the country, with 12% of children under five years of age experiencing diarrhoea.

The 2006 NDHS reported that nearly all mothers of children under five (97.8%) knew about oral rehydration salts (ORS). However, only 29% administered ORS during bouts of diarrhoea and only 40% gave either ORS or increased fluids. Zinc was virtually unheard of in Nepal with only 0.4% of caregivers providing zinc during any bout of diarrhoea in the previous two weeks.

In 2005, the Ministry of Health and Population requested assistance from the United States Agency for International Development (USAID) to support the integration of zinc into the government's diarrhoea management programme. In response, USAID has taken the lead in providing training and technical assistance to strengthen the skills of private-sector health-care providers in treating childhood diarrhoea with both ORS/ORT and zinc. At the same time, USAID/Nepal funded the local implementation of the Point-of-Use Water Disinfection and Zinc Treatment Project (POUZN). The project introduces paediatric zinc in Nepal through the private sector. Both public and private sector programmes have now been implemented in 30 districts, encompassing 65% of the population.

The POUZN programme in Nepal, although active nationwide for only six months, has already successfully contributed to an increase in zinc use from 0.4% in 2005 to nearly 16% in 2008. Of users, 85% correctly took zinc and ORS together, and 67% correctly took zinc for the full 10 days, demonstrating the positive impact of the communications messages.

A sign in rural Mozambique promotes the positive health benefits of orange-fleshed sweet potato (OFSP). OFSP is a beta-carotene-rich food that helps address the vitamin A deficiency affecting up to 70% of children in the country. © Harvest Plus

Food-based Approaches

Behaviour-centred nutrition education

Nutrition education and the use of local foods to improve access to and consumption of micronutrients was ranked highly by the Copenhagen Consensus. In remote, resource-poor environments where access to fortified products and health delivery systems is poor, sometimes it is the only option available to undernourished and vitamin-deficient populations. Promotion of leafy green vegetables, and location-specific foods, such as baobab seeds, can be a useful resource where communities far from markets must rely on their own resources to enhance micronutrient consumption.

Behaviour-centred programmes that are informed by research on local foods, local feeding behaviours and practices, and barriers to optimal feeding/food choices can be both effective and sustainable. Even in peri-urban environments, social protection programmes that have included nutrition education as part of an integrated approach have seen significant success.

Priorities for action include the need to conduct further research into best practices from community-based programmes. This will document successful nutrition education approaches and operational solutions that can be replicated and supported by existing local institutions. Further, micronutrient interventions should be integrated

with related health, nutrition and food security programmes. Finally, the provision of regionally based technical assistance to ensure quality progamme delivery will also be important.

Biofortification

Biofortification refers to the use of traditional crop breeding practices and/or modern biotechnology to produce micronutrient-dense staple crops. It is a relatively new approach to improving health that is being researched to determine the true public health potential.

Orange-fleshed sweet potato is one of the crops receiving the attention of biofortification programmes, primarily in Africa and Asia. Research was conducted on consumer preferences and local growing conditions so that new varieties could meet regional needs. Initiatives exploring the biofortification of banana, maize and rice are also being explored.

The education of farmers has proven critical to biofortification efforts. Agricultural workshops at the village level that focus on production, storage and marketability have increased interest in adoption. With the most important component being consumer acceptance of the newly introduced crops, public education efforts at the community level are vital. Adoption can be increased when varietal selection includes localized feedback on traits related to local suitability for growing conditions and acceptability for taste and preparation.

Priorities for action include the need to increase investments in biotechnology research to accelerate development and testing of biofortified crops and to ensure micronutrient content. Promoting awareness and adoption of new biofortified crops to farmers will also be important.

Food and behaviour-based approaches to address vitamin and mineral deficiencies

Community-based nutrition education programmes are a critical form of outreach in remote and resource-poor contexts. While behaviour-centred nutrition education programmes are rarely conducted solely to address a single vitamin or mineral, they can play an important and effective role as part of a comprehensive approach to addressing nutritional deficiencies.

One such model is Save the Children's Animadora Plus programme, which has been extensively tested and adapted in the most food-insecure sub-districts of Nampula in northern Mozambique. The programme is expanding coverage 10-fold and graduating volunteers who have maintained their roles with mother's groups. It has also held radio competitions that involve mothers in the delivery of carefully researched and locally appropriate messages about nutrition, childcare, and the work of the volunteers.

Almost one third of the topics in which volunteers are trained are relevant to increasing the consumption and absorption of micronutrients. These include: vitamin A-rich foods, enriched porridges for infants, nutrition in pregnancy and lactation, sweet potato promotion, balanced diet, and preservation of fruits and vegetables.

As a result, chronic malnutrition decreased by five percentage points over five years from 53.2% to 48.9%, despite a severe drought in programme districts during years three and four. Furthermore, statistically significant differences were found between underweight and wasting of programme and non-programme children. This suggests that beneficiary households maintained the nutritional status of their children through the improved nutrition and health practices promoted by the programme.

5 Low Cost: High Return Investment

This chapter returns to the compelling economic argument for investment in micronutrients. Among the evidence are:

- ✔ proven results
- ✔ relative low cost of interventions
- ✔ integration with existing health, agricultural, and other economic activities
- ✔ Copenhagen Consensus endorsement
- ✔ data on vitamin A, zinc, iron, iodine, and fortification investments

THE CASE FOR INVESTMENT in micronutrient interventions is convincing. Impressive results have been produced in a range of countries and settings, each with unique needs and challenges. Micronutrient interventions save and transform individual lives. As such, they produce national economic gains due to savings in health-care costs, maximization of investments in education, and increased economic activity. Added to these are the resulting intergenerational benefits of improved health, intellect and productivity.

On their own, such results place a moral obligation on all who are committed to achieving the Millennium Development Goals to invest in micronutrient programmes. But in this complex world of competing demands for limited resources, a compelling reason for prioritizing investment in micronutrient initiatives is their remarkable benefit:cost ratio. With the low cost of interventions and their high return in improved human capacity, the benefit:cost ratio of micronutrient programming is virtually unmatched by any other large-scale health or economic intervention.

Micronutrients are not expensive commodities. Terrific research and development has already taken place to produce low-cost supplements that are being used around the world. Fortificants used during food processing can also be procured at low cost and the technology needed to add micronutrients to food is relatively inexpensive to install. The regenerative nature of biofortification means that naturally fortified crops are eminently cost-effective.

Supplementation and fortification programmes also build on ongoing health initiatives and economic activity. From its earliest days, vitamin A supplementation has been an easy and valued addition to health outreach campaigns. Iodization and other forms of food fortification require relatively minor changes to the food production process. Zinc supplements can readily be integrated into existing health-care provision and practice. The newest multiple micronutrient powders for in-home use are a straightforward addition to public health programmes and daily household food preparation routines. Lastly, biofortified crops show great promise in reducing vitamin and mineral deficiencies through the agricultural sector.

The Copenhagen Consensus Agrees

The Copenhagen Consensus is a formidable intellectual resource in the search for solutions to the global challenges of the new millennium. It commissions and reviews research to identify the most cost-effective solutions to the world's biggest challenges.

The goal of the Copenhagen Consensus was to set priorities among a series of proposals for confronting 10 great global challenges: air pollution, conflicts, diseases, education, global warming, malnutrition and hunger, sanitation and water, subsidies and trade barriers, terrorism, women and development.

In May of 2008, a panel of eight of the world's most distinguished economists (including five Nobel laureates), was invited to consider these issues. The panel was asked to address the 10 challenge areas and to answer the question:

> What would be the best ways of advancing global welfare, and particularly the welfare of the developing countries, illustrated by supposing that an additional US$ 75 billion of resources were at their disposal over a four-year initial period?

Table 4. Copenhagen Consensus 2008: results

RANK	SOLUTION
1	**Micronutrient supplements for children (vitamin A and zinc)**
2	The Doha development agenda
3	**Micronutrient fortification**
4	Expanded immunization coverage for children
5	**Biofortification**
6	**Deworming and other nutrition programmes at school**
7	Lowering the price of schooling
8	Increase and improve girls' schooling
9	**Community-based nutrition promotion**
10	Provide support for women's reproductive role

The panel determined that vitamin A and zinc supplementation for children provided the very best return on investment in global development. Micronutrient fortification – in the form of salt iodization and flour fortification – ranked third out of a list of more than 30 options. Biofortification ranked a close fifth.

Globally, an annual investment of US$ 60 million in vitamin A and zinc supplementation combined would yield benefits of more than US$ 1 billion per year, with every dollar spent generating benefits of more than US$ 17.[90] Every dollar spent on salt iodization and flour fortification would result in benefits of more than US$ 9.[91]

The research presented to the panel demonstrated that an annual investment in micronutrient programming of US$ 1.2 billion over five years would result in annual benefits of US$ 15.3 billion, representing better health, fewer deaths and increased future earnings.

Vitamin A

Supplementation of children with vitamin A shared, along with zinc supplementation, the highest ranking by the Copenhagen Consensus for the best global return on investment. It is a highly cost-effective intervention for helping prevent illness and death among children.

Vitamin A supplementation is inexpensive on a per-child basis. The cost of the capsule itself is approximately two cents.[92] The total cost of supplementing each child with two doses per year varies by region and by degree of existing

A young mother holds her son as he receives his first dose of vitamin A from a woman health worker in Myanmar. Efforts are underway to ensure that 90% of children in the country receive regular, high-dose vitamin A supplements during their first five years of life. © UNICEF/NYHQ2005-1632/Thame

coverage, and can be reduced by combining supplementation with other programmes. Recent estimates suggest a total cost of US$ 1.20 per child per year for South Asia and sub-Saharan Africa (with significantly higher costs for Central Asia and Latin America).[93]

These cost estimates are based on large-scale national programmes serving the majority of the population. Intensified efforts needed to access those not reached by such mainstream programmes generally cost more per child, but these are often the most vulnerable children who will benefit the most from vitamin A.

Measured against the result of saved lives, the cost of vitamin A supplementation is impressive. The estimated costs per death averted range from US$ 64–500 depending on the county.[94] When considered against the result of healthy years of life gained, some estimates show the cost per DALY saved as US$ 9.[95]

Zinc

As endorsement by the Copenhagen Consensus panel indicates, zinc supplementation is quickly proving itself to be a very cost-effective method of fighting diarrhoeal disease.

The cost per zinc tablet and treatment is low. The tablets cost just two cents each, meaning that for the course of a 10–14 day treatment, the tablet cost is 20–28 cents. With the additional distribution and administration costs added, the cost of zinc supplementation as an incremental cost of diarrhoeal management is approximately 47 cents.[96] In the case of diarrhoeal management, the estimated average cost per death averted is US$ 2,100 and the cost per DALY saved is US$ 73.[97]

Disability-adjusted life year (DALY)

DALY is a measure of disease burden designed to quantify the impact of premature death and disability by combining them into a single, comparable measure. One DALY can be thought of as one lost year of "healthy" life.

Think of the sum of these DALYs across the population as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.

At this incremental cost, a five-year investment of US$ 58 million could extend therapeutic zinc supplementation coverage to 80% of 6–12 month old children in South Asia and sub-Saharan Africa – providing 58 million children with a highly effective weapon to mitigate the effects of diarrhoeal disease in their lives.[98]

A hand holds a packet of iron and folic acid tablets, a pre-natal supplement, at the Reynaldo Gutierrez laboratory in Havana, Cuba.
© UNICEF/NYHQ1995-0466/Barbour

Iron

Iron fortification shared third place with salt iodization in the ranking of the Copenhagen Consensus. The cost for fortification of wheat or maize flour is approximately 12 cents per person per year.[99] The iron compound itself accounts for a very small portion of this, with the processing and capital costs accounting for the balance.

Despite a significant expansion of flour fortification in previous years, it was estimated in 2007 that approximately 27% of flour from large mills was being fortified.[100] Because of this, flour fortification offers a phenomenal opportunity for investment in building productive capacity within nations.

Supplementation of pregnant women with iron is another cost-effective intervention that costs as little as US$ 66–115 per DALY saved in high mortality regions of Southeast Asia and sub-Saharan Africa.[101] The cost per pregnant woman is estimated to be US$ 10–50 per year, including all costs of promotion and distribution.[102]

A community health worker in rural Myanmar demonstrates how table salt turns purple when a drop of a testing solution is added, indicating the presence of sufficient iodine to prevent iodine deficiency disorders (IDD). Salt iodization costs a mere five cents per child per year. © UNICEF/NYHQ2004-1337/Noorani

Iodine

Salt iodization has been a major international success, reaping great benefits for the intellectual health of nations that have embraced it. While several regions have held back progress toward the goal of universal salt iodization, the investment required to close the gap within five years and put these regions on track is relatively small.

Each dollar invested in salt iodization returns US$ 30 in benefits.

With the cost of iodization a mere five cents per child per year,[103] it is estimated that an annual investment of US$ 19 million alone could increase iodized salt coverage to 80% from 51% in South Asia, 64% in sub-Saharan Africa and 50% in Central and Eastern Europe and the former Soviet Union.[104] This investment would benefit 380 million people.[105] The value of resulting benefits in terms of better health and increased future earnings is estimated at US$ 570 million.[106] Thus, each dollar invested returns thirty dollars in benefits.

Biofortification

Although biofortification efforts are relatively new, they are already producing promising results in terms of improved household vitamin intake and reduced deficiencies. It is estimated that the annual cost per crop, per country, ranges from US$ 500,000-1,000,000.[107] The cost per DALY saved ranges from US$ 10-120.[108]

Home Fortification

Studies on the effect of multiple micronutrient powders for in-home fortification of foods suggest great health and economic gains for users. The effects were most notable in low-income countries with high rates of infant mortality, anaemia and diarrhoea.

Estimates show the cost per death averted to be US$ 406, and the cost per DALY saved to be US$ 12-20.[109] Because of the effect of the iron supplementation on anaemia and the resulting higher cognitive functioning, the gain in earnings for each dollar spent on the multiple micronutrient powder programme is estimated to be US$ 37.[110]

Table 5. Cost-effectiveness data for a range of micronutrient interventions

INTERVENTION	REGION	COST/PERSON /YEAR (US$)	BENEFIT: COST RATIO
Vitamin A Supplementation	South Asia, Sub-Saharan Africa, East Asia	$1.20	17:1
	Central Asia	$1.60	<13:1
	Latin America and the Caribbean	$2.60	<8:1
Zinc Supplementation	South Asia, Sub-Saharan Africa, East Asia	$1.00	13.7:1
	Central Asia	$1.35	<10:1
	Latin America and the Caribbean	$2.20	<6:1
Salt Iodization		$0.05	30:1
Flour Fortification		$0.12	8:1

Source: Copenhagen Consensus best practices paper on Micronutrient supplements for child survival (Vitamin A and Zinc), Horton et al., 2008; and Copenhagen Consensus best practices paper on Food fortification (Iron and Iodine). Horton et al., in press.

6 Conclusion

Nepali community health volunteer Uma Kumari Adhikri has a son who is blind. "I know that vitamin A helps a child's eyesight so I make sure all caregivers know when the vitamin A campaign is on." © MI

IN NO SMALL WAY, the quality of every human life is determined very early on by nutrition. Without access to simple but vital micronutrients, either through diet, fortification or supplementation, an individual can suffer tremendous – otherwise avoidable – lifelong hardship.

Families, communities, societies, nations and ultimately the world all lose whenever human capital's potential is cut short. There is simply no avoiding our need for vitamins and minerals. Human capacity is built on them. As this report has documented, the good news is that despite the many causes of deficiencies and great challenges posed by the sheer numbers of people, proven, cost-effective solutions exist.

The scientific evidence is indisputable. The models for strong partnerships are here. Many challenges have already been surmounted, with effective programmes in place that warrant greater investment. Innovative research continues to create new options for micronutrient delivery. And the economic argument is authoritative.

With upwards of two billion people deficient in micronutrients, the need is great. Achieving the Millennium Development Goals by 2015 will require strategic vision on the part of those with resources to invest. Commitment and funds, supported by strong partnerships, will extend the reach of powerful micronutrient interventions and leave no one behind.

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Annex A: Selected Micronutrient Indicators by Country

COUNTRY	Proportion of pre-school age children with anaemia (Hb<110 g/L)	Proportion of pregnant women with anaemia (Hb<110 g/L)	Proportion of non-pregnant women with anaemia (Hb<120 g/L)	Proportion of pre-school age children with vitamin A deficiency (serum retinol <0.70 µmol/l)	Proportion of pregnant women with night blindness	Proportion of school-aged children with iodine deficiency (UI <100 µg/l (%))	Proportion of population at risk of inadequate intake of zinc	Proportion of households consuming adequately iodized salt (2000-2007) USI Rate (%)	Vitamin A supplementation coverage rate (6-59 months) 2007 Full Coverage (%)	Type of Wheat Flour Fortification Programme (M=Mandatory, V=Voluntary, P=Proposed)	Existence of national policy on zinc supplmentation for diarrheoa (1=Enacted, 0=Not enacted)
Afghanistan	37.9	61.0	24.7	64.5	12.5	71.9	16.4	28	92	V	1
Albania	31.0	34.0	21.1	18.6	3.2	N/A	13.4	60	–	–	0
Algeria	42.5	42.8	31.4	15.7	5.3	77.7	6.6	61	–	–	0
Andorra	12.0	15.5	16.2	0*	0*	N/A	–	-	–	–	0
Angola	29.7	57.1	52.3	64.3	10.9	N/A	46.0	35	36	V	0
Antigua and Barbuda	49.4	29.5	26.5	7.4	3.9	N/A	10.0	-	–	–	0
Argentina	18.1	25.4	18.0	14.3	3.2	N/A	3.2	90	–	M	0
Armenia	23.9	12.0	12.4	0.6	3.2	6.3	49.4	97	–	P	0
Australia	8.0	12.4	14.7	0*	0*	46.3	5.1	-	–	M	0
Austria	10.5	15.5	14.8	0*	0*	49.4	8.4	-	–	–	0
Azerbaijan	31.8	38.4	40.2	32.1	3.3	74.4	47.5	54	95	V	0
Bahamas	21.9	23.3	22.7	0*	0*	N/A	10.4	-	–	–	0
Bahrain	24.7	27.7	51.3	0*	0*	16.2	–	-	–	M	0
Bangladesh	47.0	47.0	33.2	21.7	6.5	42.5	50.4	84	94	V	1
Barbados	17.1	23.0	17.2	6.5	3.2	N/A	13.3	-	–	M	0
Belarus	27.4	25.8	19.4	17.4	2.6	80.9	5.8	55	–	P	0
Belgium	8.7	12.9	13.5	0*	0*	66.9	10.9	-	–	–	0
Belize	35.9	51.7	31.2	11.7	4.6	26.7	22.2	90	–	M	0
Benin	81.9	72.7	63.2	70.7	9.9	8.3	16.5	55	73	V	1
Bhutan	80.6	49.6	54.8	22.0	6.8	13.5	4.1	96	48	P	0
Bolivia (Plurinational State of)	51.6	37.0	32.9	21.8	14.1	19.0	22.6	90	–	M	1
Bosnia and Herzegovina	26.8	34.8	21.3	13.2	4.5	22.2	30.4	62	–	–	0
Botswana	38.0	21.3	32.7	26.1	4.3	15.3	17.1	66	–	–	1
Brazil	54.9	29.1	23.1	13.3	3.5	0.0	20.3	88	–	M	0
Brunei Darussalam	24 2	38.9	20.4	0*	0*	N/A	12.8	-	–	–	0
Bulgaria	26.7	29.7	17.7	18.3	2.8	6.9	18.6	100	–	P	0
Burkina Faso	91.5	68.3	52.0	54.3	13.0	47.5	13.3	34	73	P	1
Burundi	56.0	47.1	28.0	27.9	8.0	60.5	46.5	98	83	–	0
Cambodia	63.4	66.4	57.3	22.3	8.0	N/A	43.6	73	76	V	1
Cameroon	68.3	50.9	44.3	38.8	6.0	91.7	27.7	49	–	–	1
Canada	7.6	11.5	14.3	0*	0*	N/A	13.3	-	–	M	0
Cape Verde	39.7	41.3	32.5	2.0	6.7	77.4	16.2	0	–	–	0
Central African Republic	84.2	54.8	49.8	68.2	13.3	79.5	22.7	62	78	–	0
Chad	71.1	60.4	52.4	50.1	2.7	29.4	21.1	56	54	–	1
Chile	24.4	28.3	4.8	7.9	3.4	0.2	12.5	100	–	M	0
China	20.0	28.9	19.9	9.3	4.2	15.7	14.1	94	–	V	0
Colombia	27.7	31.1	23.6	5.9	4.1	6.4	27.4	92	–	M	0
Comoros	65.4	55.0	47.8	21.5	9.4	N/A	49.9	82	0	–	0
Congo	66.4	55.3	52.8	24.6	8.0	N/A	42.9	82	79	–	1
Cook Islands	24.7	27.2	18.2	10.4	2.8	N/A	–	-	–	–	0
Costa Rica	20.9	27.9	18.9	8.8	4.4	8.9	29.0	92	–	M	0
Côte d'Ivoire	69.0	55.1	47.4	57.3	10.3	27.6	20.8	84	4	M	0
Croatia	23.4	28.4	17.5	9.2	3.0	28.8	37.0	90	–	–	0
Cuba	26.7	39.1	19.5	3.6	3.0	51.0	49.3	88	–	M	0
Cyprus	18.6	25.2	19.6	0*	0*	N/A	6.2	-	–	–	0
Czech Republic	18.4	22.3	16.9	5.8	2.9	47.7	12.3	-	–	–	0
Democratic People's Republic of Korea	31.7	34.7	34.7	27.5	5.3	N/A	39.8	40	95	–	0
Democratic Republic of the Congo	70.6	67.3	52.8	61.1	10.4	10.1	57.5	79	79	V	1
Denmark	9.0	12.4	14.3	0*	0*	70.8	9.2	-	–	–	0
Djibouti	65.8	56.2	46.4	35.2	9.1	N/A	37.3	0	94	–	1

COUNTRY	Proportion of pre-school age children with anaemia (Hb<110 g/L)	Proportion of pregnant women with anaemia (Hb<110 g/L)	Proportion of non-pregnant women with anaemia (Hb<120 g/L)	Proportion of pre-school age children with vitamin A deficiency (serum retinol <0.70 µmol/l)	Proportion of pregnant women with night blindness	Proportion of school-aged children with iodine deficiency (UI <100 µg/l (%))	Proportion of population at risk of inadequate intake of zinc	Proportion of households consuming adequately iodized salt (2000-2007) USI Rate (%)	Vitamin A supplementation coverage rate (6-59 months) 2007 Full Coverage (%)	Type of Wheat Flour Fortification Program (M=Mandatory, V=Voluntary, P=Proposed)	Existence of national policy on zinc supplmentation for diarrheoa (1=Enacted, 0=Not enacted)
Dominica	34.4	35.1	23.7	4.2	3.6	N/A	7.4	-	–	–	0
Dominican Republic	34.6	39.9	27.1	13.7	4.5	86.0	44.7	19	–	M	1
Ecuador	37.9	37.8	29.2	14.7	3.7	0.0	29.6	99	–	M	0
Egypt	29.9	45.4	27.6	11.9	5.0	31.2	8.6	78	87	M	1
El Salvador	18.4	10.5	26.8	14.6	4.3	4.6	41.7	62	13	M	1
Equatorial Guinea	40.8	41.7	38.4	13.9	8.3	N/A	–	33	–	–	1
Eritrea	69.6	55.3	52.1	21.4	11.6	25.3	32.4	68	50	P	1
Estonia	23.4	22.7	17.7	8.7	2.6	67.0	8.4	-	–	–	0
Ethiopia	75.2	62.7	52.3	46.1	22.1	68.4	21.7	20	86	–	1
Fiji	39.1	55.6	31.8	13.6	3.8	75.4	15.2	31	–	M	0
Finland	11.5	15.0	15.3	0*	0*	35.5	5.7	-	–	–	0
France	8.3	11.5	9.1	0*	0*	60.4	4.2	-	–	–	0
Gabon	44.5	46.2	36.7	16.9	10.5	38.3	18.6	36	0	–	1
Gambia	79.4	75.1	59.1	64.0	7.9	72.8	36.1	7	82	–	0
Georgia	40.6	41.6	22.7	30.9	3.7	80.0	47.3	87	–	V	0
Germany	7.8	12.3	12.3	0*	0*	27.0	12.5	-	–	–	0
Ghana	76.1	64.9	43.1	75.8	7.7	71.3	21.0	32	77	M	1
Greece	12.1	18.6	14.6	0*	0*	N/A	10.8	-	–	V	0
Grenada	32.0	31.4	24.0	14.1	3.2	N/A	15.2	-	–	M	0
Guatemala	38.1	22.1	20.2	15.8	6.8	14.4	48.3	40	29	M	1
Guinea	79.0	63.2	50.4	45.8	17.8	32.4	33.9	51	94	M	1
Guinea-Bissau	74.9	57.7	52.9	54.7	11.3	N/A	29.0	1	64	–	0
Guyana	47.9	52.0	53.9	4.1	3.5	26.9	31.9	-	–	M	0
Haiti	65.3	63.2	54.4	32.0	9.4	58.9	55.6	3	–	M	0
Honduras	29.9	32.4	14.7	13.8	4.8	31.3	44.3	80	–	M	1
Hungary	18.8	20.7	16.6	7.0	2.7	65.2	14.7	-	–	V	0
Iceland	7.8	11.8	14.1	0*	0*	37.7	3.1	-	–	–	0
India	74.3	49.7	52.0	62.0	12.1	31.3	25.9	51	33	V	1
Indonesia	44.5	44.3	33.1	19.6	1.7	16.3	34.4	73	87	M	1
Iran (Islamic Republic of)	35.0	40.5	33.0	0.5	4.0	19.7	6.7	99	–	M	0
Iraq	55.9	38.2	45.3	29.8	7.0	N/A	18.5	28	–	M	0
Ireland	10.3	14.8	17.5	0*	0*	60.8	5.2	-	–	P	0
Israel	11.8	17.4	18.6	0*	0*	N/A	12.2	-	–	V	0
Italy	10.9	15.5	14.4	0*	0*	55.7	9.1	-	–	–	0
Jamaica	48.2	40.7	23.8	29.4	4.5	N/A	22.6	100	–	M	1
Japan	10.6	14.8	21.3	0*	0*	N/A	23.5	-	–	–	0
Jordan	28.3	38.7	28.6	15.1	4.4	24.4	8.3	88	–	M	0
Kazakhstan	36.3	26.0	35.5	27.1	2.6	53.1	9.6	92	–	V	1
Kenya	69.0	55.1	46.4	84.4	6.4	36.8	32.9	91	15	V	1
Kiribati	41.9	38.4	30.7	21.8	4.6	N/A	33.7	-	–	P	0
Kuwait	32.4	31.3	28.7	0*	0*	31.4	4.2	-	–	M	0
Kyrgyzstan	49.8	34.1	38.0	26.3	3.3	88.1	13.8	76	95	M	0
Lao People's Democratic Republic	48.2	56.4	46.1	44.7	11.9	26.9	35.7	84	69	–	0
Latvia	26.7	25.0	18.9	13.0	2.6	76.8	10.7	-	–	–	0
Lebanon	28.3	31.6	25.2	11.0	3.7	55.5	8.0	92	–	–	0
Lesotho	48.6	25.4	27.3	32.7	4.4	21.5	31.2	91	38	V	1
Liberia	86.7	62.1	58.0	52.9	13.3	3.5	59.2	-	85	–	1
Libyan Arab Jamahiriya	33.9	34.5	29.9	8.0	4.2	N/A	5.2	90	–	P	0
Lithuania	23.8	24.2	17.9	11.1	2.6	62.0	8.9	-	–	–	0
Luxembourg	9.4	10.3	18.8	0*	0*	30.7	31.5	-	–	–	0

COUNTRY	Proportion of pre-school age children with anaemia (Hb<110 g/L)	Proportion of pregnant women with anaemia (Hb<110 g/L)	Proportion of non-pregnant women with anaemia (Hb<120 g/L)	Proportion of pre-school age children with vitamin A deficiency (serum retinol <0.70 µmol/l)	Proportion of pregnant women with night blindness	Proportion of school-aged children with iodine deficiency (UI <100 µg/l (%))	Proportion of population at risk of inadequate intake of zinc	Proportion of households consuming adequately iodized salt (2000-2007) USI Rate (%)	Vitamin A supplementation coverage rate (6-59 months) 2007 Full Coverage (%)[i]	Type of Wheat Flour Fortification Program (M=Mandatory, V=Voluntary, P=Proposed)	Existence of national policy on zinc supplmentation for diarrheoa (1=Enacted, 0=Not enacted)
Madagascar	68.3	50.1	45.6	42.1	7.5	N/A	32.9	75	95	–	1
Malawi	73.2	47.3	43.9	59.2	5.8	N/A	34.2	50	90	V	0
Malaysia	32.4	38.3	30.1	3.5	4.4	57.0	14.1	-	–	V	0
Maldives	81.5	55.4	49.6	9.4	4.6	43.1	13.7	44	62	–	0
Mali	82.8	73.4	61.0	58.6	19.1	68.3	11.1	79	89	P	1
Malta	16.3	26.1	15.6	4.0	3.7	N/A	10.6	-	–	–	0
Marshall Islands	30.0	38.1	24.1	60.7	4.3	N/A		-	39	–	0
Mauritania	68.2	52.7	50.4	47.7	9.7	69.8	14.0	2	89	–	0
Mauritius	16.8	37.5	14.0	9.2	4.0	4.4	29.5	0	–	–	0
Mexico	29.4	26.2	20.8	26.8	3.8	8.5	20.2	91	–	M	0
Micronesia (Federated States of)	18.7	37.8	24.2	54.2	3.6	N/A	–	-	–	–	0
Monaco	5.0	6.3	13.3	0*	0*	N/A	–	-	–	–	0
Mongolia	21.4	37.3	13.6	19.8	3.4	52.8	1.6	83	94	P	0
Montenegro	29.5	33.6	26.7	17.2	3.3	N/A	–	71	–	–	0
Morocco	31.5	37.2	32.6	40.4	2.2	63.0	7.6	21	–	M	0
Mozambique	74.7	52.4	48.2	68.8	5.3	68.1	60.5	54	42	P	1
Myanmar	63.2	49.6	44.9	36.7	1.1	22.3	34.6	60	93	–	1
Namibia	40.5	30.6	35.0	17.5	6.2	28.7	14.2	63	–	–	0
Nauru	20.0	19.2	25.7	10.0	8.9	N/A	–	-	–	–	0
Nepal	78.0	74.6	66.7	32.3	19.6	27.4	21.3	63	95	V	1
Netherlands	8.7	12.5	14.2	0*	0*	37.5	7.3	-	–	–	0
New Zealand	11.3	17.6	10.2	0*	0*	65.4	4.6	83	–	M	0
Nicaragua	17.0	32.9	9.0	3.1	5.1	0.0	49.7	97	–	M	1
Niger	81.3	65.5	62.2	67.0	17.1	0.0	9.4	46	95	P	1
Nigeria	76.1	66.7	62.0	29.5	7.7	40.4	12.8	97	55	M	1
Niue	21.6	31.7	11.9	15.5	3.0	N/A	–	-	–	–	0
Norway	6.4	9.3	13.3	0*	0*	N/A	8.0	-	–	–	0
Oman	50.5	42.7	34.0	5.5	4.4	49.8	–	61	–	M	0
Pakistan	50.9	39.1	27.9	12.5	7.8	63.6	11.1	17	95	V	1
Palau	22.2	27.3	21.1	8.9	3.7	N/A	–	-	–	–	0
Panama	36.0	36.4	40.3	9.4	4.7	8.6	33.0	95	–	M	0
Papua New Guinea	59.8	55.2	43.1	11.1	10.3	27.7	14.6	-	7	P	0
Paraguay	30.2	39.3	26.2	14.1	4.5	13.4	13.4	94	–	M	0
Peru	50.4	42.7	40.4	14.9	6.5	10.4	41.6	91	–	M	0
Philippines	36.3	43.9	42.1	40.1	7.9	23.8	31.9	45	83	M	1
Poland	22.7	25.3	18.7	9.3	2.8	64.0	9.5	-	–	V	0
Portugal	12.7	17.3	15.0	0*	0*	N/A	9.9	-	–	–	0
Qatar	26.2	29.1	36.2	0*	0*	30.0	–	-	–	M	0
Republic of Korea	16.5	22.6	14.0	0*	0*	N/A	19.4	-	–	–	0
Republic of Moldova	40.6	36.5	23.4	25.6	5.1	62.0	30.8	60	–	P	0
Romania	39.8	30.0	20.1	16.3	3.0	46.9	18.3	74	–	P	0
Russian Federation	26.5	20.8	19.8	14.1	2.8	56.2	11.7	35	–	P	0
Rwanda	41.9	10.6	59.4	6.4	7.9	0.0	39.8	88	76	–	1
Saint Kitts and Nevis	22.9	25.6	20.8	7.1	2.9	N/A	11.5	100	–	–	0
Saint Lucia	32.2	33.4	25.0	11.3	3.7	N/A	7.8	-	–	–	0
Saint Vincent and the Grenadines	32.3	32.7	24.1	2.1	3.8	N/A	20.7	-	–	M	0
Samoa	35.5	33.4	19.7	16.1	3.3	N/A	–	-	–	P	0
San Marino	9.1	11.3	16.5	0*	0*	N/A	–	-	–	–	0
Sao Tome and Principe	36.7	40.4	26.2	95.6	5.0	N/A	36.7	37	48	–	0
Saudi Arabia	33.1	32.0	32.3	3.6	5.1	23.0	9.4	-	–	M	0

COUNTRY	Proportion of pre-school age children with anaemia (Hb<110 g/L)	Proportion of pregnant women with anaemia (Hb<110 g/L)	Proportion of non-pregnant women with anaemia (Hb<120 g/L)	Proportion of pre-school age children with vitamin A deficiency (serum retinol <0.70 µmol/l)	Proportion of pregnant women with night blindness	Proportion of school-aged children with iodine deficiency (UI <100 µg/l (%))	Proportion of population at risk of inadequate intake of zinc	Proportion of households consuming adequately iodized salt (2000-2007) USI Rate (%)	Vitamin A supplementation coverage rate (6–59 months) 2007 Full Coverage (%)	Type of Wheat Flour Fortification Program (M=Mandatory, V=Voluntary, P=Proposed)	Existence of national policy on zinc supplmentation for diarrheoa (1=Enacted, 0=Not enacted)
Senegal	***70.1***	***57.6***	***48.4***	***37.0***	12.7	75.7	25.3	41	94	P	1
Serbia	29.5	***33.6***	26.7	***17.2***	***3.3***	20.8	–	73	–	–	0
Seychelles	***23.8***	***24.9***	***21.1***	***8.0***	***3.2***	N/A	18.8	-	–	–	0
Sierra Leone	***83.2***	***59.7***	***62.9***	***74.8***	***9.7***	N/A	56.7	45	86	–	1
Singapore	***18.9***	***23.8***	18.4	0*	0*	N/A	–	-	–	P	0
Slovakia	***23.4***	***25.2***	***19.4***	***8.3***	***2.9***	15.0	16.4	-	–	–	0
Slovenia	***14.0***	***18.9***	***15.1***	0*	0*	N/A	12.5	-	–	–	0
Solomon Islands	***51.7***	***51.1***	***39.2***	***13.1***	***6.6***	N/A	22.8	-	–	P	0
Somalia	N/A	N/A	N/A	***61.7***	***12.8***	N/A	17.1	1	4	–	0
South Africa	24.1	***21.8***	***26.4***	***16.9***	***4.5***	29.0	19.7	62	–	M	1
Spain	***12.9***	***17.6***	***16.3***	0*	0*	50.1	9.0	-	–	–	0
Sri Lanka	29.9	29.3	31.6	35.3	***3.5***	30.0	44.7	94	–	V	0
Sudan	84.6	***57.7***	***43.5***	***27.8***	***9.6***	62.0	10.8	11	90	V	1
Suriname	***25.7***	***32.4***	***20.4***	***18.0***	***4.8***	N/A	30.2	-	–	M	0
Swaziland	***46.7***	***24.3***	***36.5***	***44.6***	***4.1***	34.5	20.5	80	32	V	0
Sweden	***8.6***	***12.9***	***13.3***	0*	0*	N/A	11.3	-	–	–	0
Switzerland	***6.3***	9.7	***12.2***	0*	0*	24.0	7.6	-	–	–	0
Syrian Arab Republic	***41.0***	***39.3***	***33.4***	***12.1***	***4.6***	N/A	6.5	79	–	V	0
Tajikistan	37.7	***44.6***	41.2	26.8	***3.8***	N/A	66.8	46	92	V	1
Thailand	25.2	22.3	17.8	***15.7***	***3.7***	34.9	41.6	47	–	–	0
The former Yugoslav Republic of Macedonia	25.8	***31.8***	12.2	29.7	***3.3***	8.7	11.3	94	50	–	0
Timor-Leste	31.5	22.9	31.5	***45.8***	13.4	N/A	–	60	64	–	0
Togo	***52.4***	***50.2***	***38.4***	***35.0***	***9.5***	6.2	22.9	25	–	P	0
Tonga	***27.6***	***34.0***	***21.5***	***17.0***	***3.0***	N/A	–	-	–	–	0
Trinidad and Tobago	***30.4***	***29.7***	***24.3***	***7.2***	***3.7***	N/A	36.9	28	–	M	0
Tunisia	21.7	32.3	26.3	***14.6***	***4.5***	26.4	6.8	97	–	–	0
Turkey	32.6	***40.2***	***26.3***	***12.4***	***5.4***	60.9	22.2	64	–	P	0
Turkmenistan	35.8	***29.9***	47.3	***28.0***	***3.4***	18.7	24.2	87	–	P	1
Tuvalu	***34.2***	***33.1***	26.3	***21.8***	***3.6***	N/A	–	-	–	–	0
Uganda	64.1	41.2	28.7	27.9	8.3	3.9	23.8	96	–	V	1
Ukraine	22.2	***27.3***	9.2	***23.8***	***2.5***	70.1	15.8	18	–	V	0
United Arab Emirates	***27.7***	***27.9***	***43.9***	0*	0*	56.6	7.5	-	–	V	0
United Kingdom of Great Britain and Northern Ireland	8.0	***15.2***	8.8	0*	0*	N/A	8.6	-	93	M	0
United Republic of Tanzania	71.8	58.2	47.2	24.2	2.7	37.7	22.9	43	93	V	1
United States of America	3.1	5.7	6.9	0*	0*	15.9	9.1	-	–	M	0
Uruguay	***19.1***	***27.1***	***16.9***	***11.9***	***3.2***	N/A	4.0	-	–	M	0
Uzbekistan	38.1	53.8	64.8	53.1	***3.4***	39.8	24.4	53	84	V	1
Vanuatu	***59.0***	57.3	54.1	***16.1***	***11.8***	N/A	18.0	-	–	P	0
Venezuela (Bolivarian Republic of)	***33.1***	***39.6***	***28.3***	***9.4***	***4.7***	0.0	41.0	90	–	M	0
Viet Nam	34.1	32.2	24.3	12.0	***4.1***	84.0	27.8	93	95	V	0
Yemen	***68.3***	***58.1***	***51.0***	***27.0***	***9.8***	30.2	13.1	30	47	M	0
Zambia	52.9	46.9	29.1	54.1	5.7	72.0	38.0	77	95	V	1
Zimbabwe	19.3	18.8	34.3	35.8	4.6	14.8	43.4	91	83	V	1
SOURCE	WHO, CDC. Worldwide prevalence of anaemia 1993-2005. WHO global database on anaemia. Geneva, World Health Organization, 2008.	WHO, CDC. Worldwide prevalence of anaemia 1993-2005. WHO global database on anaemia. Geneva, World Health Organization, 2008.	WHO, CDC. Worldwide prevalence of anaemia 1993-2005. WHO global database on anaemia. Geneva, World Health Organization, 2008.	WHO. Global prevalence of vitamin A deficiency in populations at risk 1995-2005. WHO global database on vitamin A deficiency. Geneva, World Health Organization, in press.	WHO. Global prevalence of vitamin A deficiency in populations at risk 1995-2005. WHO global database on vitamin A deficiency. Geneva, World Health Organization, in press.	WHO global database on iodine deficiency (http://www.who.int/vmnis/iodine/data/en/index.html, accessed 31 July 2007)	IZINGG. Estimated Risk of Zinc deficiency by Country, FNB vol. 25, no 1 suppl 2 (2004)	UNICEF global database on iodized salt consumption)	UNICEF Vitamin A programme database: Supplementation coverage	FFI database	Zinc Task Force, using data from UNICEF, USAID and WHO

Values in bold italics are regression based estimates

** Countries with a GDP ≥ US$ 15,000 are assumed to be free of vitamin A deficiency of public health significance.*

A united call to action

The development of this report was coordinated through an Interagency Steering Committee including high-level participation from the following agencies:

FLOUR FORTIFICATION INITIATIVE (FFI)

FFI is a network of individuals and organizations working together to make flour fortification standard practice worldwide. FFI serves as a catalyst for local partnerships which encourage flour fortification. FFI also provides advocacy materials and training and technical resources.

www.sph.emory.edu/wheatflour

THE GLOBAL ALLIANCE FOR IMPROVED NUTRITION (GAIN)

GAIN fights malnutrition to make people and economies healthier and more productive. GAIN stimulates public-private partnerships and provides financial and technical support to get fortified food and supplements to those most at risk of malnutrition.

www.gainhealth.org

MICRONUTRIENT INITIATIVE (MI)

The Micronutrient Initiative is an Ottawa-based, international not-for-profit organization dedicated to ensuring that the world's most vulnerable – especially women and children – in developing countries get the vitamins and minerals they need to survive and thrive, through supplementation and food fortification programmes. Its mission is to develop, implement and monitor innovative, cost-effective and sustainable solutions for hidden hunger, in partnership with others.

www.micronutrient.org

THE UNITED NATIONS CHILDREN'S FUND – UNICEF

UNICEF is on the ground in over 150 countries and territories to help children survive and thrive, from early childhood through adolescence. UNICEF uses a holistic approach to improve the nutritional status of both mother and child, with special emphasis on pregnancy, breast-feeding and the first three vulnerable years of life. Good nutrition, especially in the first several years of a child's life, profoundly affects every stage of a child's survival, growth and development, and is essential in ensuring that all children reach their full potential.

www.unicef.org

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

USAID is the official federal agency within the U.S. government by which development assistance is provided to other countries. USAID's long-range economic and social development assistance efforts focus on economic growth, agriculture and trade, health, democracy, conflict prevention and humanitarian assistance. Nutrition programmes have been a critical component of USAID's foreign assistance for over 40 years.

www.usaid.gov

WORLD BANK

The World Bank is a vital source of financial and technical assistance to developing countries around the world. The World Bank is made up of two unique development institutions owned by 185 member countries—the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). Together these two institutions provide low-interest loans, interest-free credits and grants to developing countries for a wide array of purposes that include investments in education, health, public administration, infrastructure, financial and private sector development, agriculture, and environmental and natural resource management.

www.worldbank.org

WORLD HEALTH ORGANIZATION (WHO)

WHO is a specialized agency of the United Nations (UN) that acts as a coordinating authority on international public health. WHO was established in 1948 and the headquarters is in Geneva, Switzerland. The Department of Nutrition for Health and Development coordinates nutrition efforts in WHO focusing in four strategic areas covering 1) the development and operationalization of integrated food and nutrition policies; 2) intelligence of needs and response; 3) the development of evidence-based programme guidance and 4) the rationale for investment and action in health and nutrition.

www.who.int/nutrition

The agencies would like to acknowledge the efforts of Barbara Strang, who acted as primary author, Alison Lane, who acted as editor, and colleagues at the US Centers for Disease Control and Prevention, who contributed greatly to this report.

Investing in the future

A united call to action on vitamin and mineral deficiencies

Around the world, billions of people live with vitamin and mineral deficiencies

Vitamins and minerals are vital components of human health, advancing physical and intellectual development in important ways. However, billions of people currently live with deficiencies in a range of crucial vitamins and minerals – including vitamin A, iodine, iron, zinc and folate. The results of these deficiencies are significant:

- Vitamin A deficiency annually claims the lives of almost 670,000 children under five.
- Iron deficiency anaemia during pregnancy is associated with 115,000 deaths each year, accounting for one fifth of total maternal deaths.

Cost-effective solutions are ready to be scaled-up

Working together, national governments, donors, science and industry have made huge strides in delivering cost-effective solutions to vulnerable populations.

Fortification

- Fortifying flour and other staple foods with vitamin A, folic acid, iron and zinc has been an effective means of reducing anaemia and birth defects.
- Salt iodization reduces goitre and improves cognitive development. In communities where iodine intake is sufficient, average IQ is shown to be on average 13 points higher than in iodine-deficient communities.

Supplementation

- Where a population is at risk of vitamin A deficiency, providing young children with vitamin A supplementation every six months reduces mortality by an average of 23%.
- Zinc supplementation, given with oral rehydration therapy, can reduce the duration and severity of acute diarrhoea, one of the leading causes of death of children.

World's best investment for development

The benefit:cost ratio of micronutrient programming is unmatched by any other large-scale health or economic intervention. In 2008, the Copenhagen Consensus panel considered 30 options and ranked the provision of micronutrients as the world's best investment for development.

For more information, please visit

www.unitedcalltoaction.org

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