

Bringing science to bear

Science and technology will never solve all of the problems associated with the inadequate food and care and the lack of health services and sanitation that lead to childhood malnutrition. But the successes stemming from breakthroughs being made and insights reached have stirred new hope for healthier, more productive lives for both children and adults. This section describes some of the crucial scientific advances that are helping to shape specific interventions to reduce malnutrition or that may do so in the future.

Some of this knowledge, such as the strengthening effect of vitamin A on the immune system, is well established; other knowledge is just emerging and is worth watching. Some of the new science is likely to accelerate efforts to reduce malnutrition, and at the same time generate new understanding of how reducing malnutrition in childhood or during the prenatal period may lessen chronic disease in adulthood and the onerous public health burden it causes. There are also new

tools to tackle the essential task of nutritional assessment and new ways that agricultural science can be brought to bear on the problem.

Nutritionally acquired immune deficiency

It is estimated that the immune systems of some 23 million people worldwide have been damaged by HIV.¹ It is less well known that malnutrition impairs the immune systems of at least 100 million young children and several million pregnant women, none of them infected by HIV. But unlike the situation with AIDS, the 'cure' for immune deficiency due to malnutrition has been known for centuries: It is achieved by ensuring an adequate dietary intake containing all essential nutrients. Today, more is being learned about the specific role of individual nutrients in the functioning of the immune system, knowledge that will help in the design of interventions that can improve the situation in the near future. This knowledge also reinforces the importance of striving to ensure that everyone in the world has access to a diet that is adequate in both quality as well as quantity.

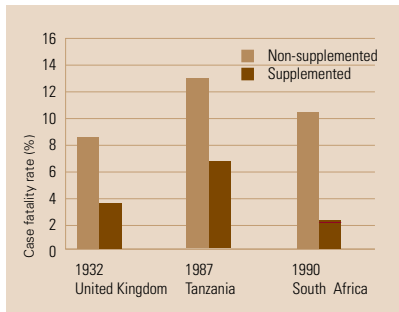
Scientists have known for some time that malnutrition and infection are connected. A 1968 monograph by WHO, entitled 'Interactions of Nutri-

The 'cure' for immune deficiency due to malnutrition has been known for centuries: It is achieved by ensuring an adequate dietary intake containing all essential nutrients.

Photo: Over a million pre-school-age children suffer from vitamin A deficiency, which affects immune-system functioning. Vitamin A supplementation is estimated to lower a child's risk of dying by 23 per cent. In Bangladesh, a boy receives a vitamin A capsule.

Fig. 11 Measles deaths and vitamin A supplementation

In three separate trials of children hospitalized with measles — one as early as 1932 — deaths among children given high-dose vitamin A supplements were significantly lower than among children not supplemented. The consistent results suggest that a change in vitamin A status can rapidly alter basic physiological functions concerned with cellular repair and resistance to infection, thereby saving lives.



Source: Alfred Sommer and Keith P. West Jr., *Vitamin A Deficiency: Health, survival and vision*, Oxford University Press, New York, 1996.

tion and Infection’, was one of the first comprehensive statements of some of these links.

The threat that vitamin A deficiency poses to the lives of young children has already been described. Within a few years, the scientific community went from calling the fact that vitamin A supplements could reduce child mortality “too good to be true” to calling it “too good not to be true.” But the many ways vitamin A deficiency increases child deaths were not well understood until recently. Now the results of a dozen field studies, conducted in Brazil, Ghana, India, Indonesia, Nepal and elsewhere, indicate that supplementing the diets of children who are at risk of vitamin A deficiency can reduce deaths from diarrhoea. Four of the studies that focused on diarrhoea showed that deaths were reduced by 35-50 per cent. The vitamin can also halve the number of deaths due to measles² (Fig. 11).

In Bangladesh, breastfed infants whose mothers were given a single oral high-dose supplement of vitamin A shortly after giving birth had significantly fewer days of sickness because of respiratory infections and febrile illnesses during the first six months of life than did infants born to unsupplemented mothers from the same socioeconomic group in the same area.³

Zinc is another micronutrient that has long been known to be essential for the growth and development of cells and for the functioning of the immune system. However, because zinc deficiency is extremely difficult to measure, little attention was paid until recently to the possibility that it might impair child health and development (Fig. 12).

Trials in Bangladesh, India and Indonesia have already shown reductions of about one third in the duration and severity of diarrhoea in children receiving zinc supplements and a

median 12 per cent decline in the incidence of pneumonia.⁴ In these investigations, zinc supplements did the most good for those children who started out the most malnourished.

A study recently completed in Lima (Peru) found that the benefits of zinc supplementation on immunity can begin even before birth. Researchers from the Johns Hopkins School of Public Health in Baltimore (US) and the Instituto de Investigación Nutricional in Lima have been adding zinc to the iron and folate supplements of pregnant women and testing its impact on the health of their newborn children, including its effects on immune system activity. Initial analysis shows that antibody levels just after birth are higher in the children of zinc-supplemented mothers than in those receiving a placebo.

Zinc supplementation appears so effective in reducing the incidence of diarrhoea and pneumonia in poor countries that one scientist, Robert Black of Johns Hopkins University, has suggested that zinc supplements are as significant a public health intervention for diarrhoea reduction as improvements in water and sanitation. And major new research indicates that even the effects of malaria, a deadly enemy of both children and adults, may be lessened by zinc and vitamin A (Panel 18).

Iron deficiency can also damage the immunity of a growing child, impairing the body’s ability to kill invading pathogens and leading to increased illness in iron-deficient populations.⁵ In studies in Egypt, anaemic children had longer and more severe episodes of diarrhoea than did their iron-fortified peers.

Basic science is now able to explain why these astonishing results occur. Thus far, zinc and vitamin A are the two micronutrients that have proved to be the most closely linked

with the proper functioning of the body's front-line defences. These two micronutrients help maintain the physical barriers of skin and mucosa that prevent micro-organisms from invading the body, as well as enhancing the activity of leukocytes such as NK (natural killer) cells and macrophages — scavenger cells that engulf, then destroy, foreign pathogens such as bacteria throughout the body.

Equally important, low dietary consumption of zinc and vitamin A reduces the number and impairs the development and function of two types of B-cells — key players in 'acquired immunity'. These produce antibodies and T-cells that, in turn, are responsible for eliminating virus-infected host cells. They also produce biochemicals known as cytokines, which further promote B-cell and macrophage activity. At the same time, an adequate intake of zinc is now understood to be necessary in order for both vitamin A and iodine to do many of their vital jobs.

Nutrition and AIDS

The role of nutrition in preventing infection is now being investigated as one possible way to help reduce the transmission of AIDS. Vitamin A may form part of the arsenal needed to combat HIV, which is expected to infect between 4 million and 5 million children by early in the next century, most of them in sub-Saharan Africa. These children will mainly be infected by their mothers.

The routes of mother-to-child transmission of HIV, also known as vertical transmission, are threefold: during pregnancy, during labour and delivery, and through breastfeeding.

Scientists have been exploring the possibility of reducing vertical transmission in all three routes since 1994. They have tried to block intrauterine

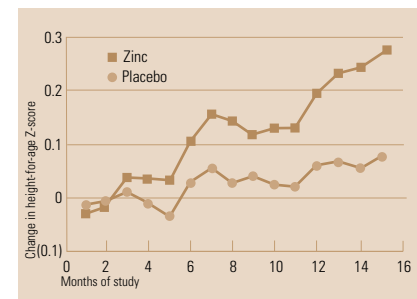
transmission by giving women doses of the antiretroviral drug Zidovudine during pregnancy. The drug has been shown to reduce mother-to-child transmission of HIV — but at hundreds of dollars per course, it is prohibitively expensive for most people in the developing world. Less expensive methods of antiretroviral therapy during pregnancy, such as administering Zidovudine for shorter periods or using cheaper drugs, are now being tested in Haiti, sub-Saharan Africa and South-East Asia.

Two other treatments during pregnancy are also under investigation. These involve either intravenous therapy with purified anti-HIV antibodies, or supplementation with vitamin A. In a 1994 study of HIV-infected women in Malawi, it was found that 32 per cent of those who were vitamin A deficient during pregnancy had passed HIV on to their infants. In contrast, only 7 per cent of HIV-infected women with sufficient levels of vitamin A did so. The study concluded that vitamin A-deficient women were thus four and a half times more likely to infect their children.⁶

Also, a 1995 study from Kenya reported that the concentration of HIV in breastmilk is higher in vitamin A-deficient mothers than in those with good vitamin A status. Another study, also from Kenya, has shown that HIV-positive women who are also vitamin A deficient were five times more likely than non-vitamin A-deficient women to shed HIV-infected cells in their reproductive tracts, a factor that may be an important determinant of both sexual and vertical transmission of AIDS. However, some experts have suggested that these results may have come about not because of the influence of vitamin A on HIV transmission, but because poor vitamin A status and high rates of infection occur together for other reasons.

Fig. 12 Zinc supplementation and child growth (Ecuador, 1986)

Zinc's importance in ensuring normal growth and development is underlined in a 1986 study of Ecuadorian pre-schoolers with low zinc intake. The children were paired by sex, age and height; one in each pair was given a zinc supplement, the other a placebo. The results over 15 months showed a slow, steady gain in the supplemented children's height as compared with the non-supplemented group.



Note: The height-for-age Z-scores in the chart refer to the number of standard deviations below or above the median height for healthy children in the same age group.

Source: H. Dirren et al., 'Zinc supplementation and child growth in Ecuador', in *Nutrient Regulation during Pregnancy, Lactation and Infant Growth*, Plenum Press, New York, 1994.

Zinc and vitamin A: Taking the sting out of malaria



UNICEF/97-0556/Clausen

Early evidence from a study in Papua New Guinea suggests that zinc and vitamin A supplements may boost children's resistance to one of the world's most insidious infectious diseases: malaria.

Two fifths of the world's population, in 90 countries across sub-Saharan Africa, Asia and Central and South America, is at risk of contracting malaria. At least 300 million people worldwide endure its recurrent fevers, malaise, anaemia and risk of seizures or coma. Malaria kills from 1.5 million to 2.7 million people annually. It is the sixth leading cause of disability among children under four years of age in the developing world. Some 600,000 young children die of malaria alone each year; over 1 million die of malaria in conjunction with other illnesses — a rate of one child every 30 seconds.

Many approaches have already been tried to combat the disease. However, the parasite that causes malaria is no longer vulnerable to

some of the most powerful anti-malarial compounds available. For a time, the widespread use of pesticides in the 1950s managed to suppress the *Anopheles* mosquito that transmits the parasite, but it, too, has developed resistance.

Arming the body to defend itself through immunization is one approach to preventing the disease. But vaccines are difficult to develop since the parasite moves between organs, changing its appearance from stage to stage and hiding from the immune system in a place that the immune system doesn't check: inside red blood cells. Consequently, the best vaccines to date have managed to protect only around 30 per cent of test populations from infection.

However, naturally acquired resistance does develop over time as people are repeatedly exposed to the parasite. A recent study by the Johns Hopkins School of Public Health and the Papua New Guinea Institute of Medical Research investigated the

ability of vitamin A and zinc to help boost such natural resistance.

Nearly 800 children under the age of five were enrolled in the study. All of the children lived in an area of north-western Papua New Guinea where malarial infection is common. The parasite that is responsible for the disease can be found in the blood of over 40 per cent of under-fives in the region, and it is the major cause of death among children from the age of six months to four years.

In controlled trials, regular vitamin A and zinc supplementation appeared to be complementary in decreasing the burden of malaria in children. According to Dr. Anuraj Shankar of Johns Hopkins University, chief researcher of the study, vitamin A reduced by more than a third the febrile illnesses due to mild to moderately high levels of malaria parasites in children and significantly reduced spleen swelling, an indicator of chronic malaria. However, it had little influence on the worst cases, where children had a very high number of parasites in their blood.

Zinc, on the other hand, helped blunt the severity of the worst cases. As a result, there were over a third fewer malaria cases seen at health centres among those given zinc than among those given a placebo. In addition, overall clinic visits by those children who had received zinc decreased by a third, and signs of other infections (cough and diarrhoea, for example) were reduced by 20–50 per cent.

The Papua New Guinea experience shows that vitamin A and zinc status in children may be as important in reducing malaria as other commonly used malaria-control techniques, such as insecticide spraying and the use of insecticide-treated bed nets. And the cost is minimal:

A year's supply of zinc supplements costs \$1 per child, with an additional 10 cents for vitamin A capsules.

A second study is under way in the Peruvian Amazon to measure the effectiveness of vitamin A and zinc in boosting the efficacy of antimalarial drugs. Peruvian scientists at the Loreto Department of Health and colleagues from Johns Hopkins are studying more than 1,000 children who are suffering from malaria to see if a short, five-day course of zinc or vitamin A in conjunction with antimalarial drugs improves their health. Some children are receiving both the micronutrients, in the hope that the zinc-vitamin A combination will be more effective, as zinc is known to promote vitamin A metabolism in the body.

Despite the surge of international interest in malaria from both the public sector and private industry and the promise that vitamin A and zinc may hold, funding for research into disease prevention and treatment unfortunately remains meagre. Currently, funding levels run at roughly \$42 per malaria death, compared with \$3,274 for each AIDS fatality.

Photo: Women and their children wait outside a UNICEF-assisted health centre in the Peruvian Amazon, where malaria is a major health concern.

Based on the findings of the first studies — and to demonstrate whether the connection between vitamin A and HIV transmission is causal — four clinical trials were begun recently to examine HIV transmission rates in women who have received vitamin A supplements during the second or third trimester of pregnancy. Results from these studies, conducted in Malawi, South Africa, Tanzania and Zimbabwe on a total of nearly 3,000 HIV-infected women, are expected soon.

Using nutrition to reduce maternal deaths

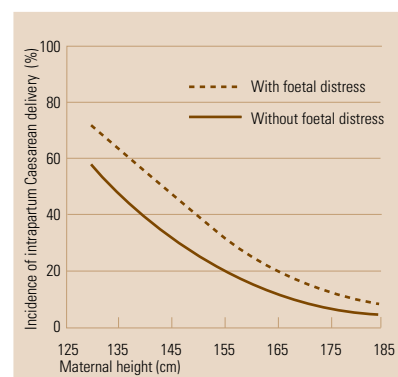
Maternal mortality is a tragedy in social, economic and public health terms. WHO and UNICEF have noted that of the 585,000 yearly maternal deaths around the world, the vast majority are preventable. About 80 per cent of these deaths are the result of five direct obstetric causes: haemorrhage, infection, obstructed labour, unsafe abortion and a convulsive disorder in late pregnancy called eclampsia.⁷

As already noted, obstructed labour is more likely to occur among women who were stunted in childhood (Fig. 13). It is estimated that anaemia may be responsible for as much as 20 per cent of maternal mortality, particularly those deaths from haemorrhage and possibly infection. Anaemia also increases the risk of morbidity and mortality associated with any major surgical intervention, including Caesarean section.

Programmes already exist to reduce anaemia in pregnant women. More work is needed, however, not only to make iron/folate supplementation programmes more effective, but also to improve the treatment and prevention of malaria and hookworm. Both of these are conditions that also contribute to maternal anaemia.

Fig. 13 Maternal height and Caesarean delivery (Guatemala, 1984-1986)

The importance of good nutrition for girls and women is affirmed in a mid-1980s' study of pregnant Guatemalan women, which found that the risk of having an intrapartum Caesarean delivery was 2.5 times higher in short mothers than in tall mothers. Short stature in women is often a consequence of poor growth in early childhood.



Source: Kathleen M. Merchant and José Villar, 'How do maternal and newborn size affect risk of foetal distress and intrapartum Caesarean delivery?' (draft).

Impact of deficiency

Vitamin A deficiency makes children especially vulnerable to infection and worsens the course of many infections. Supplementation with vitamin A is estimated to lower a child's risk of dying by approximately 23 per cent. The deficiency is also the single most important cause of blindness among children in developing countries.

Who is affected

Over 100 million pre-school-age children suffer from vitamin A deficiency. Vitamin A deficiency is also likely to be widespread among women in their reproductive years in many countries.

What vitamin A does

Vitamin A, stored normally in the liver, is crucial for effective immune-system functioning, protecting the integrity of epithelial cells lining the skin, the surface of the eyes, the inside of the mouth and the alimentary and respiratory tracts. When this defence breaks down in a vitamin A-deficient child, the child is more likely to develop infections, and the severity of an infection is likely to be greater.

Depending on the degree of the deficiency, a range of abnormalities also appears in the eyes of vitamin A-deficient children. In the mildest form, night-blindness occurs because the rods in the eye no longer produce rhodopsin, a pigment essential for seeing in the dark. In more severe forms, lesions occur on the conjunctiva and the cornea that if left untreated can cause irreversible damage, including partial or total blindness.

Sources

Vitamin A is found as retinol in breastmilk, liver, eggs, butter and whole cow's milk. Carotene, a precursor of vitamin A that is converted to retinol in the abdominal walls, is found in green leafy vegetables, orange and yellow fruits, and red palm oil.

Even if an adequate nutritional status were achieved in adolescent girls and women before their first pregnancy, this would never eliminate the need for good medical care in pregnancy and childbirth. But some day it may help reduce the tragic burden of maternal mortality and the need for certain medical interventions. Some of the connections between nutrition and maternal mortality suggested below are not yet definitively demonstrated or part of programme activities, but they hold great promise for the future. A few are especially worth mentioning:

► Even given the many known benefits of good vitamin A status, it is nonetheless remarkable to find that improving the vitamin A status of pregnant women whose intake of the vitamin is low also dramatically reduces maternal mortality (Panel 1). Deadly infections in pregnancy, as in childhood, find a formidable adversary in vitamin A. The use of low-cost, low-dose vitamin A capsules as well as improvements in diet make it highly probable that this new research will be easily incorporated into programmes.

► Zinc deficiency, increasingly recognized as widespread among women in developing countries, is associated with long labour, which increases the risk of death. Severe zinc deficiency is also believed to impair foetal development in a number of ways. Zinc is important for the synthesis of hormones and enzymes essential to childbirth — especially estrogen-dependent functions such as expulsion of the placenta and proper contraction of uterine muscles during birth — as well as for immune-system development. A number of studies around the world have found that zinc supplementation has reduced complications of pregnancy. Several studies are under way that will soon help define

the impact of improved zinc status on pregnant women.

► It has long been known that iodine deficiency in women increases the risk of stillbirths and miscarriages. And there is evidence that, in highly iodine-deficient areas, another result of this deficiency may be increased maternal mortality through severe hypothyroidism.

► A recent study in the United States showed that calcium supplementation did not reduce the risk of hypertension in pregnancy that could result in death, but a number of experts have suggested that supplementation might reduce this risk in areas where women are especially calcium deficient.

► Folate deficiency, now well known to induce neural-tube birth defects if it is present during the first month of pregnancy, may also represent a risk for maternal morbidity and mortality, as well as increase the risk of low birthweight.

The clear message emerging from these connections is that improving women's nutritional status — by increasing their intake of micronutrients as well as their overall food consumption, and by taking steps to reduce their workload and improve their access to health care — may offer considerable, low-cost benefits in reducing maternal deaths. But there is still no international consensus on the benefits to be gained by supplementation during pregnancy with nutrients other than iron and folate.

The real challenge is to reach women well before they become pregnant — indeed, to help adolescent girls achieve the best nutritional status possible before they enter their reproductive years. This would not only help reduce maternal mortality but would also reduce the prevalence of low birthweight, the risk of birth defects and the rates of stillbirths and early infant mortality. All of these re-

main scientific and programmatic challenges, along with the imperative of ensuring that women's health is positioned high on the health and development agendas of all countries.

Breastfeeding: Good for mothers' health too

In addition to the nutritional status of adolescent girls and women, there is another important connection between nutrition and maternal mortality. A number of studies have shown a strong link between the early initiation of breastfeeding and reduced risk of postpartum haemorrhage.

Initiating breastfeeding immediately following birth, as most women do in baby-friendly hospitals, stimulates the contraction of the uterus and reduces blood loss. For this reason, the continuing spread of the Baby-Friendly Hospital Initiative should also contribute to the reduction of maternal mortality.

In recent years, research has also demonstrated that this immediate post-partum benefit is by no means the only way in which breastfeeding can improve women's health. A recent large-sample study in the United States demonstrated that women who breastfed their children had a lower risk of breast cancer in the premenopausal period, and the longer they breastfed, the lower the risk.⁸ These results show that protecting, promoting and supporting breastfeeding has benefits for women that go beyond the remarkable effects, already well understood, that protect their children from illness and death.

Prevention of chronic diseases

Chronic degenerative diseases are largely regarded as diseases of afflu-

ence. In industrialized countries, improvements in living standards and health care have led to increased life expectancy, allowing people to live long enough to develop such chronic illnesses. Chronic diseases are also associated with the sedentary lifestyle and over-abundant diet prevalent in many industrialized nations.

Arguments are being made, however, that these chronic diseases in large measure may also be diseases of poverty — particularly poverty early in life and during foetal development. The hypothesis is particularly intriguing in light of the fact that ischaemic heart disease is projected to be the world's leading cause of death and disability in the year 2020.⁹

Professor David Barker and his colleagues at the Medical Research Council (MRC) Environmental Epidemiology Unit in Southampton (UK), first raised the "foetal origins of adult disease" hypothesis over a decade ago, noting a link between low birthweight and the incidence of cardiovascular disease among middle-aged men and women born in the United Kingdom.¹⁰

Since then, over 30 studies around the world have indicated that low-birthweight babies who were not born prematurely have a higher incidence of hypertension later in life than those with a normal birthweight,¹¹ independent of their social class and such adult risk factors as smoking, drinking and overeating.

Low birthweight, as well as thinness at birth, has also been correlated with glucose intolerance in childhood¹² and non-insulin dependent diabetes in later life.¹³

Professor Barker and his colleagues speculate that maternal dietary imbalances at critical periods of development in the womb can trigger a redistribution of foetal resources, affecting a foetus's structure and metabolism in ways that predispose the

Impact of deficiency

Zinc deficiency in malnourished children contributes to growth failure and susceptibility to infections. Zinc deficiency is also thought to be associated with complications of childbirth.

Who is affected

Data on the prevalence of zinc deficiency are unavailable, as there is no reliable method of determining zinc status at the population level. Zinc deficiency is likely to be a public health problem, however, in areas where overall malnutrition is prevalent; it is now recognized as such in many countries.

What zinc does

Zinc promotes normal growth and development. It forms part of the molecular structure of 80 or more known enzymes that work with red blood cells to move carbon dioxide from tissues to lungs. Zinc also helps maintain an effective immune system. Severe zinc deficiency causes growth retardation, diarrhoea, skin lesions, loss of appetite, hair loss and, in boys, slow sexual development. Zinc has now been shown to have a therapeutic effect on diarrhoea cases.

Sources

Breastmilk has small amounts of zinc that are readily absorbed. Other sources include whole-grain cereals, legumes, meat, chicken and fish. Vegetables and fruits contain little zinc but when eaten with cereals may increase the bio-availability of zinc in cereals.

Impact of deficiency

Iron deficiency anaemia, the most common nutritional disorder in the world, impairs immunity and reduces the physical and mental capacities of populations. In infants and young children, even mild anaemia can impair intellectual development. Anaemia in pregnancy is an important cause of maternal mortality, increasing the risk of haemorrhage and sepsis during childbirth. Infants born to anaemic mothers often suffer from low birthweight and anaemia themselves. Causes include blood loss associated with menstruation and parasitic infections such as hookworm, but an inadequate intake of iron is the main cause.

Who is affected

Nearly 2 billion people are estimated to be anaemic and even more are iron deficient, the vast majority of them women. Between 40 and 50 per cent of children under five in developing countries — and over 50 per cent of pregnant women — are iron deficient.

What iron does

The body needs iron to produce haemoglobin, the protein in red blood cells responsible for carrying oxygen. Iron is also a component of the many enzymes essential for the adequate functioning of brain, muscle and the immune-system cells.

A certain amount of iron is stored in the liver, spleen and bone marrow. Iron deficiency develops as these stores are depleted and there is insufficient iron absorption. In anaemia, the iron deficiency is so severe that the production of haemoglobin is significantly reduced. The main symptoms and signs are paleness of the tongue and inside the lips, tiredness and breathlessness. Deficiencies of folic acid, vitamin A, ascorbic acid, riboflavin and various minerals can also contribute to anaemia.

Sources

Iron is found in liver, lean meats, eggs, whole-grain breads and molasses.

individual to later cardiovascular and endocrine diseases. The correlation between low birthweight and later cardiovascular disease and diabetes may arise from the fact that nutritional deprivation in utero ‘programmes’ a newborn for a life of scarcity. The problems arise when the child’s system is later confronted by a world of plenty.¹⁴

In central India, an ambitious study has been funded by UK Wellcome Trust and coordinated by Dr. Ranjan Yajnik at the King Edward Memorial Hospital Research Centre in Pune (India) and Dr. Caroline Fall at the MRC Environmental Epidemiology Unit. It is exploring the impact that a mother’s nutrition may have on the development of diabetes, high blood pressure and coronary heart disease in her offspring when they reach adulthood. The results could resolve some of the uncertainties about causation of chronic illness, offering nutritional information relevant to both developing and industrialized countries.

The study has followed over 800 women through pregnancy, monitoring foetal growth, maternal weight gain and biochemical indicators of nutritional status.¹⁵ The nutritional value of the women’s daily food intake — including calorie, protein and micronutrient content — was measured and recorded. Within 24 hours of birth, both infant and placenta were weighed and other body measurements made.¹⁶ Almost one third of the nearly 800 infants born during the study were classified as low birthweight, under 2.5 kg.¹⁷ An interesting early finding suggests that birthweights are most strongly associated with the size of the mother — not just her weight gain during pregnancy, a well-known determinant of newborn size, but also her weight, height, percentage of body fat and head circumference *before* conception. The weight and body mass index of

many of the women before pregnancy suggested chronic undernutrition. The study also suggested that women’s diet during pregnancy did not appear to have influenced foetal size substantially, although regular consumption of two particular items — green leafy vegetables and dairy products — was associated with larger birth size. These early findings lend support to the premise that building a sturdy baby depends on good nutrition for the expectant mother throughout her life.

The children from the Pune study are growing up in a society of increasing urbanization and prosperity. Urban dwellers in India are already five times more likely to develop diabetes than their rural relatives,¹⁸ and those who have migrated to industrialized countries like the United Kingdom die in significantly larger numbers from coronary heart disease than their indigenous white counterparts.¹⁹

In 1999, the first of the children in the study will be tested for signs of glucose intolerance and insulin resistance; these are early hints of diabetes that have already been noted in children of low birthweight in Pune.²⁰ Soon after, blood pressure monitoring will begin in an effort to look for initial signs of hypertension. As the study progresses, findings can be related back to birth size, foetal growth and maternal diet before and during pregnancy. From an undertaking of this magnitude, clear evidence may emerge about the importance of improving maternal nutrition as a means of preventing chronic later-life disease in children — before these children have children of their own.

New ways to reduce malnutrition deaths in emergencies

The sheer extent of mild and moderate malnutrition makes these conditions

responsible for much more sickness and death globally than does severe malnutrition. But a severely malnourished child — usually defined as under 70 per cent of the median weight-for-height reference or having oedema (water retention and swelling) at least in the feet — is at very high risk of death, and requires prompt and intensive care in a health facility.

Until recently, health professionals dealing with severe malnutrition in emergency situations or in large hospitals in poor countries had been using an approach practised for years. The protocol was to treat infectious conditions, correct rehydration and feed, at least in the early stages, with high-energy milk — usually a combination of dried skim milk, vegetable oil and sugar. In the last few years, however, with the help of WHO and the benefit of the experience of a number of NGOs specializing in this field, the new protocol is improving the treatment of severe malnutrition.

While the new protocol retains some elements of former standard practices, there are significant changes. The milk now recommended for the early stages of therapeutic feeding, for example, is enhanced by the addition of both oil and a vitamin and mineral mix, which addresses the special micronutrient imbalance that accompanies severe malnutrition. Called F-100 because it gives 100 kilocalories per 100 grammes, the milk optimizes the chance for rapid weight gain and the eventual recovery of a severely malnourished child.

Another important change is a new recommendation calling for modification of the standard oral rehydration salts (ORS) to address the special electrolyte needs of severely malnourished children. The use of standard ORS has been known to increase risk of heart failure and sudden death

among certain severely malnourished children. The revised ORS reduces that risk. Known as ReSoMal (rehydration solution for malnutrition), it contains more potassium and different concentrations of elements from those in standard ORS.

The new protocol for the care of the severely malnourished also emphasizes elements that have been known by nutrition workers for some time, but perhaps not well enough to be integrated into regular practice. These include the need for rapid attention to clinical factors, such as low body temperature (hypothermia) and low body sugar (hypoglycaemia), as well as to less strictly medical factors such as meeting malnourished children's great needs for emotional support, intellectual stimulation and play. Experienced emergency nutrition personnel working in places such as the Great Lakes region of Central Africa and the Democratic People's Republic of Korea have adopted this method and noted how quickly it helps reduce mortality. One challenge is to ensure that supplies of the appropriate high-energy milk and rehydration solution are steady and sufficient (Panel 19).

New ways to measure malnutrition

Much of the new knowledge described above will contribute to effective actions to reduce malnutrition and related conditions. But even when actions are effective, assessing their impact is often difficult. Measuring malnutrition initially can also pose problems — and make it difficult to place the issue on the policy and programme agenda.

There is thus a need for assessment and analysis techniques that are low in cost, produce rapid results and are easy to use and understand. Here are some of the promising new tools:

Impact of deficiency

Iodine deficiency is the single most important cause of preventable brain damage and mental retardation, most of the damage occurring before birth. It also significantly raises the risk of stillbirth and miscarriage for pregnant women.

Who is affected

The successful global campaign to iodize all edible salt is reducing the risk associated with this deficiency, which threatened 1.6 billion people as recently as 1992. Nevertheless, it is estimated that 43 million people worldwide are suffering from varying degrees of brain damage; there are an estimated 11 million overt cretins. Some 760 million people have goitres.

What iodine does

Iodine is needed by the thyroid gland for normal mental and physical development. Most commonly and visibly associated with goitre (a swelling of the neck as the enlarged thyroid works to collect iodine from the blood), iodine deficiency takes a graver toll in impaired mental acuity. Persons suffering from IDD face a range of serious impairments including cretinism, spastic diplegia (a spastic paralysis of the lower limbs) and dwarfism. Less severe deficiencies in both adults and children can mean the loss of 10 to 15 intelligence quotient (IQ) points, as well as impaired physical coordination and lethargy.

Sources

Iodized salt is the best source of iodine. Sea fish and some seaweed also contain iodine, although sea salt does not.

Protecting nutrition in crises



UNICEF/94-0277/Press

When refugees stream into a country, when families lose their homes, fields and crops in war or disaster, when children cry from hunger, it is not surprising that food can seem like the only priority and the only answer to averting widespread malnutrition.

But in emergencies as well as in other situations, *food, health and care* are all crucial to saving lives. Access to basic health services and water and sanitation facilities is essential in emergencies not only to keep children alive, but also to protect their growth and development. To prevent outbreaks of measles, mass immunization usually along with the distribution of vitamin A supplements has become standard practice in emergencies. In Haiti, for example, a measles vaccination campaign in 1994-1995 reached almost 3 million children, helping end an epidemic that began when the country was in the midst of civil unrest.

Preventing death and malnutrition from cholera and other diarrhoeal diseases — through adequate sanitation, access to safe water and oral rehydration therapy — saved thousands of children's lives in the recent emergencies in Rwanda and Somalia. This is standard practice in the current emergency in Burundi, for example.

Breastfeeding is an important element of nutrition-related 'care' in emergencies. There has been marked progress in this area as governments and agencies become increasingly sensitive to supporting women's ability to breastfeed. Workers with some NGOs that specialize in preventing malnutrition in times of crisis have had success in recent years in promoting relactation — helping women who may have been separated from their children to begin breastfeeding again after having stopped.

Sometimes infant formula must be used in emergencies — for in-

stance, when young children have been separated from their mothers. In these cases, all UN agencies working in emergencies and many NGOs have committed to supplying only generically labelled (no brand name) formula, to prevent commercial exploitation of emergency situations. During the conflict in Bosnia and Herzegovina, UNICEF and other UN agencies jointly urged that infant formula distribution be severely limited, and relief organizations subsequently ended mass distribution programmes in January 1995. UNICEF and WHO strongly promoted breastfeeding, targeting health workers and joining with local health professionals during and after the war to develop a national policy on infant feeding.

Children ages 6 to 18 months, pregnant women and women who are breastfeeding all need energy-dense, nutrient-dense foods. In emergencies, the approach to meeting these special needs varies. Agencies that are part of the International Federation of Red Cross and Red Crescent Societies, for example, try to provide a family ration to meet everyone's requirements, including those of children and pregnant and breastfeeding women. The World Food Programme and some other agencies generally distribute a ration that meets minimum needs and, in addition, they cover vulnerable groups with supplementary feeding programmes. The comparative benefits of the two approaches need to be evaluated.

Triple A — assessment, analysis and action — is an essential approach in emergencies as well as in other situations. Monitoring children's nutritional status, with weight-for-height a commonly used indicator, is crucial during emergencies to help target resources and reach the most affected.

Early warning systems and emergency preparedness are cost-effective means to prevent malnutrition in emergencies. The United Nations Department of Humanitarian Affairs' early warning system draws on the work of similar systems within and outside the United Nations in preparing comprehensive assessments of potential emergency situations, and UNHCR and other agencies have set up rapid deployment mechanisms for emergencies. Nonetheless, early warning systems and emergency planning and preparedness remain sadly underfinanced, a shortfall that endangers children in particular when crises loom.

Photo: Health workers vaccinate two girls at a camp for unaccompanied Rwandan refugee children in the Democratic Republic of the Congo.

► ***A simplified way to look for vitamin***

A: Population-level surveys of vitamin A status have been a particular challenge. In the past, when it was thought that the main impact of vitamin A deficiency was damaged eyes and blindness, population surveys of vitamin A status involved examining children's eyes for early signs of damage. Now that it is understood that this deficiency has lethal consequences on a subclinical level — that is, at levels of deficiency that do not yet show up as damage to the eye — more sensitive methods of detecting its presence are needed.

Most of the national or regional vitamin A surveys that have been conducted in recent years have used blood retinol as the principal indicator of vitamin A status. There are some difficulties with the interpretation of this indicator, and it is expensive and difficult to collect and analyse the venous blood samples needed for these surveys.

A new technique that promises to be easier, cheaper and less invasive is 'dark adaptometry'. This method, which has been tested and found effective in several field situations,²¹ takes advantage of the fact that in very early stages of vitamin A deficiency the ability of the pupil of the eye to constrict under illumination is impaired. By flashing a simple handheld light at one pupil and covering the other, the degree of impairment of the pupillary reflex can be estimated. It is hoped that this simple method, which is non-invasive, will become widely available soon.

► ***'Dipsticks' for iodine deficiency:***

Iodine deficiency disorders (IDD) can be assessed in populations by palpating goitres, but this method requires a high level of training and is less useful as goitres begin to disappear with better access to iodized salt.



UNICEF/98-1726/Lemoyne

Interaction and stimulation are essential to sound nutrition as well as intellectual and emotional development. In China, a boy delights in his meal and the attention of his aunt.

Since iodine excreted in the urine is a good indicator of iodine consumed, IDD can be reliably detected by analysing urine samples. Many countries have undertaken urinary iodine surveys, which involve collecting samples, preserving them carefully and sending them to a laboratory for analysis in a central location.

A new technique may eliminate some of those steps and much of the cost. A reagent-treated testing strip or ‘dipstick’ now being developed will simplify the procedure by allowing the iodine content of urine to be analysed and read directly on the spot without transporting samples to a laboratory. It is hoped that this tool will soon be available for field surveys.

► **Improved test kits for iodized salt:**

Simple iodized salt test kits have helped make salt-testing a community affair. Anyone can use the small plastic bottles of test solution that cause salt to turn blue if it is iodized, and some countries have distributed these kits to schoolchildren, teachers and community workers. The test kits, however, have a limited shelf life, and they do not distinguish very sensitively among levels of salt iodization. Work is now under way to improve the test kit in both these respects and make it an even more useful assessment tool.

► **Computerizing anaemia surveys:**

Thanks to computer chips, assessment of anaemia at the population level is becoming easier. There have been methods for some time to assess peripheral blood (from a fingertip, for example) without sending the samples to a laboratory, but some of them are slow and inaccurate.

Portable electronic haemoglobinometers are now available, however, that enable blood to be drawn easily from a finger into a small cuvette that is inserted directly into a machine that

gives a digital read-out of the precise haemoglobin level in a few seconds. The wider use of these machines in population surveys will help to raise awareness of the enormous magnitude of the anaemia problem.

New ways to enrich diets

There are many ways to enhance foods to improve the content of the vitamins and minerals that are so important for the well-being of children and their families. Food fortification is one very important way of doing this, and has already helped overcome micronutrient deficiencies in many industrialized countries and some developing ones.

But many of the world’s poorest people eat locally grown crops that cannot be fortified. Agricultural scientists are now demonstrating that staple crops can be modified in several ways at the breeding stage, with great nutritional benefit.

The grains and tubers on which the vast majority of people in the developing world depend have certain inherent shortcomings nutritionally. For one thing, these staples tend not to provide all the minerals and vitamins needed to ensure good nutrition. In addition, cereals, depending on several factors, including the degree to which they are refined, contain substances that impede the ‘bioavailability’ of some important minerals — the ability of the body to absorb and use them. The most important of these substances is known as phytate, a molecule containing phosphorus. Micronutrients usually come from non-staple foods — animal products, vegetables and fruits. But the poorest populations often cannot afford these foods and depend on the grains and tubers they can afford. This fact helps explain the high

prevalence of some micronutrient deficiencies.

Agricultural research has turned to the science of plant breeding to improve this situation. The goal is to develop staple food crops that contain higher quantities of essential micronutrients — or lower amounts of phytate. In this connection, work is currently being done in the United States to develop low-phytate grain foods for animal consumption. Such grains hold nutritional promise for people as well, according to the results of a recent study, which found that human volunteers absorbed iron at a significantly higher rate from foods prepared using a new low-phytate strain of corn than from an older higher-phytate strain.²²

The Consultative Group on International Agricultural Research, made up of 17 internationally funded agricultural research centres, is trying to raise farm productivity and food consumption in developing countries. The group is now coordinating a global effort to increase the micronutrient content of five major staple food crops: rice, wheat, maize, beans and cassava. The aim is to breed plants that load high amounts of vitamins and minerals into their edible parts — and also into their seeds, allowing them to enrich themselves for subsequent harvests without changing their taste, texture, or the ease with which they are grown.

In developed countries, such crops have already been successfully produced: high-zinc wheat, for example, is being grown in Australia. Estimates are that it will take 6 to 10 years to breed comparable new plants in developing countries. Scientists believe that they will not only improve the daily dietary intake in the developing world but will also significantly increase crop yields because these micronutrient-dense plants have better

germination and more resistance to infection at the vulnerable seedling stage.

More effective action for nutrition improvement

The technical advances described in this report, whether new research on nutrition and illness or better ways to detect problems, are not magic bullets. They will contribute to sustainable improvement in nutrition only if they sharpen the ability of people, including the poor, to assess and analyse the causes of malnutrition around them — and to plan and carry out appropriate responses.

Recent advances in the fields of social science and communication will also help accelerate and sharpen people's ability to take control of actions to reduce malnutrition.

Actions described here to improve child nutrition and thereby improve growth, resistance to illness and cognitive development need to be coupled with other highly effective low-cost interventions that have already been proven to prevent disease and improve child development.

Some of these have yet to be widely exploited. For example, intestinal worms, which contribute to poor growth and development, can be combated through routine deworming using low-cost drugs that are both very safe and highly effective (Panel 20). And child deaths from malaria can be reduced through the use of insecticide-impregnated mosquito nets. These measures have not received adequate global attention and resources, even though every child has a right to their benefits.

Actions to prevent malnutrition in young children also need to be linked to efforts to promote early child development through stimulating play and early learning, and by strengthen-

Impact of deficiency

Folate deficiency causes birth defects in the developing foetus during the earliest weeks of pregnancy — before most women are aware that they are pregnant. Folate deficiency has been found to be associated with a high risk of pre-term delivery and low birthweight, though it is not clear that this would hold in all populations. Folate deficiency also contributes to anaemia, especially in pregnant and lactating women.

Who is affected

Although data are not abundant, in several developing countries women in their reproductive years have been found to have very high rates of folate deficiency. Young children are also likely to be at risk.

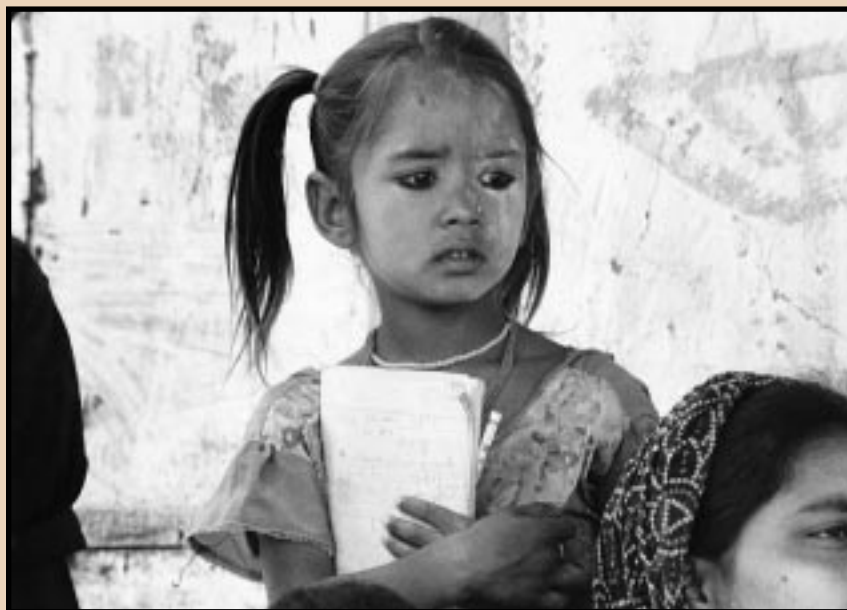
What folate does

This B vitamin helps in the formation of red blood cells. Folate also regulates the nerve cells at the embryonic and foetal stages of development, helping to prevent serious neural tube defects (of the brain and/or spinal cord).

Sources

Folate is found in almost all foods, but the best sources are liver, kidney, fish, green leafy vegetables, beans and groundnuts.

Progress against worms for pennies



UNICEF/5847/Vilas

Asksed to name the most widespread diseases, few people would think of including worms. Yet, helminth (worm) infections are indeed one of the most common — and neglected — of diseases, affecting more than 30 per cent of the world's people. Health, productivity and physical and mental capacity may all suffer.

Children in developing countries are the most severely affected, particularly those between the ages of 5 and 14, in whom intestinal worms account for up to 12 per cent of total disease burden — the largest single contributor. While the impact of worms on health and growth is commonly believed to be most significant in children after they reach the age of five, a new study in India links worm infection with growth faltering in children between one and four years old.

As many as 150,000 children die each year from intestinal obstruction

and other abdominal complications caused by large adult worms. In millions more, worms are a significant cause of malnutrition, stunting growth and causing severe anaemia, dysentery, delayed puberty and problems with learning and memory. In 1990, an estimated 44 million pregnant women were infected with hookworm; their foetuses, therefore, were at risk of retarded intrauterine growth, prematurity and low birthweight.

Transmission is insidiously easy, especially where hygiene and sanitation are inadequate. A child walking barefoot can pick up hookworm; by putting a dirty finger in her mouth, she may ingest roundworm eggs. It is not uncommon for a child to carry up to 1,000 hookworms, roundworms and whipworms that deplete blood and nutrients.

Overall, about 1.5 billion people have roundworms, making it the third most common human infection in the world. Whipworm infects 1 bil-

lion people, including nearly one third of all children in Africa. More than 1.3 billion people carry hookworm in their gut, and 265 million people are infected with schistosomes, the parasites that cause the debilitating disease of schistosomiasis.

Worms affect nutrition in several ways, ingesting blood and leading to the loss of iron and other nutrients. Worms also cause the lining of the intestines to change, which reduces the surface membrane available for digestion and absorption. As a result, fat, certain carbohydrates, proteins and several vitamins (including vitamin A) are not absorbed properly. Lactose intolerance and poor use of available iron can also result.

Treatment is simple and relatively inexpensive. A single dose of anti-worm medicine such as Mebendazole costs as little as 3 cents and can eliminate or significantly reduce intestinal worm infections. The total cost of treatment programmes is typically \$1 to \$2 per year per person. Controlled experiments in India, Indonesia, Malaysia, Myanmar and Tanzania have proved that the therapy works for months at a time. UNICEF, WHO and the World Bank have identified pre-school and school-age children, women of childbearing age and adolescent girls as those who would benefit most from worm control programmes.

The benefits are impressive. An innovative study in Kenya in 1994, which used motion detectors on the thighs of school children, found that ridding the youngsters of high levels of hookworm improved physical activity. Dewormed children reported better appetites and an end to abdominal pains and headaches. Within nine weeks, the treated group showed better growth, weight gain (both in

terms of fat deposits and muscle mass), physical activity and appetite than the untreated group. Numerous studies have also noted the mental and cognitive effects of anaemia in children infected with worms, with intellectual performance improving after treatment.

In a large-scale study done in India in 1996, two groups of children ages one to four years received twice-yearly vitamin A supplements; one group was also given deworming tablets. At the end of the trial, the children in the group given worm treatment were on average 1 kg heavier than the children who were not treated. The study shows not only that mass deworming can improve the weights of young children in areas where worms are common, but it also opens up the practical possibility of combining worm treatment with vitamin A supplementation in areas at risk.

Some believe that deworming is not a satisfactory solution because it must be repeated in the absence of improved sanitation, hygiene and health education, and reinfection occurs frequently. Nevertheless, periodic deworming reduces helminths' drain on children's development at critical times in their lives, at least until the causes and conditions of environmental contamination and infection are successfully addressed.

Photo: One of the most common infections in the world, worms impede children's growth and cause anaemia. Learning and memory suffer. Here, a girl attends school in India.

ing interaction with parents and peers. The parents of young children everywhere need regular contact with people who can help check their children's growth and development and can provide advice and support on breastfeeding and complementary feeding. In many communities, parents and caregivers will also need both advice on and access to supplements of vitamin A, iron, iodine and other micronutrients. Support in these areas might best be provided through established formal institutions — health centres, clinics or pre-school centres (Panel 21). But where such facilities do not exist or do not function, children cannot wait for them to be built or staffed.

Communities must receive overall support in their efforts to ensure that all families have access to basic preventive actions to improve the nutrition of children and pregnant women. This includes strengthened health services to prevent and treat disease, and increased support to stimulate early child learning, care and development.

None of the preventive and supportive actions to promote child growth and development described in this report require a doctor or nurse or a trained educator. Communities can be helped to organize themselves to provide or administer these services, and in most communities, groups that can take on these responsibilities already exist. Communities can also be helped to assess their own priority problems and can learn to monitor the effectiveness of their actions, re-designing their own programmes accordingly. Combined with the use of effective low-cost technologies, the adoption of these measures could result in rapid improvements not only in child survival but also in child development, nutritional status and learning capacity.



UNICEF/97-0423/Toutoumji

A girl enjoys an ear of corn in the United States, where researchers have developed a new strain of corn that increases the body's ability to absorb iron.

Child nutrition a priority for the new South Africa



UNICEF/South Africa

Under apartheid, South Africa had a highly sophisticated medical research infrastructure that served the white minority, pioneering heart transplants, for example. Yet the majority of the people were left with poor health and nutrition care. The advent of democratic rule in 1994, however, changed all that. The Government is now reorienting the health system to the needs of the majority, and child nutrition is a priority.

Establishing a community-level nutrition monitoring system is an important part of this effort, and one area where this approach is taking shape is the Bergville district of KwaZulu-Natal Province. Child health and nutrition problems in the province are among the most challenging in the country. Over half the children

live in poverty, nearly 40 per cent have vitamin A deficiency, up to one quarter of the children in rural areas are stunted, and iodine deficiency is a problem in mountainous areas. Ten per cent of children ages six months to five years suffer from anaemia, which is also prevalent among pregnant women, and low birthweight is common.

In the Bergville district, with a population of 120,000, a network of community health workers and health assistants is being trained as part of the new Child Survival Programme. The approach, based on regular weighing of young children in their homes to monitor growth, is similar to that used successfully in other developing countries during the past decade. Health workers will use the weighing sessions to discuss chil-

dren's growth with their families, reinforcing positive trends and exploring reasons behind faltering growth to devise solutions. To carry out the programme, the number of community health workers in the district will be expanded significantly. The main objective is to cover all families, including the poorest and most marginalized.

Community participation in planning and operating health services is at the core of the programme. Community members formed a health forum in 1994, which serves as the steering committee of the Child Survival Programme. The group has helped establish a district hospital board and local committees to supervise health workers and has organized workshops on the new programme.

Since 1996, resources for health care have been channelled more equitably to disadvantaged provinces such as KwaZulu-Natal, and this will help finance the improved health services. The University of Natal in Pietermaritzburg is taking a leading role in supporting child growth monitoring in the Bergville district. In addition, World Vision of South Africa, an NGO which has been active in the district since 1980, has helped lay the groundwork for the programme through various community development projects. These include local leadership training, skills training for women's groups, support for a pre-school and crèche programme and cooperation with the health service in addressing malnutrition.

The new system for monitoring growth is sorely needed, according to a recent survey, which found that while most mothers had a health services card for monitoring child growth, many of the cards were either left

blank or were incomplete. The survey also found that very little nutritional counselling had accompanied growth monitoring.

The new programme faces many difficulties: Resources are stretched, personnel must be trained and there must be outreach into communities. Nonetheless, the new partnerships being forged between government, the university, NGOs and communities represent an approach that holds promise for the future.

A major effort to tackle vitamin A deficiency is also under way. Within months after the new Government took office, the South African Vitamin A Consultative Group launched the country's largest-ever nutrition survey, covering nearly 20,000 households. The survey found that one third of children ages six months to five years are vitamin A deficient or on the borderline. The Government and non-governmental partners are gearing up to address the problem. Steps planned include giving vitamin A supplements to young children and to mothers shortly after giving birth, fortifying staple foods with vitamin A and encouraging the production and consumption of vitamin A-rich foods.

Photo: In South Africa, community health workers weigh children and discuss growth promotion with their families.

It has often been said that meeting this challenge is a matter of political will. In a \$28 trillion global economy, the problem is surely not a lack of resources. But it may be more useful to see the challenge as a matter of political choice. Governments in poor and rich countries alike may choose to allow children to be intellectually disabled, physically stunted and vulnerable to illness in childhood and later life. This is the price of doing little or nothing to ensure good nutrition.

But governments could instead resolve to move to consolidate lessons already learned about reducing malnutrition. They could do everything possible to mount massive actions that can clearly succeed and that can be implemented by communities themselves. And they could encourage research on, and implementation of, new and better actions.

For the well-being and protection of children and the human development of the world, the course of action is clear.

Governments could instead resolve to move to consolidate lessons already learned about reducing malnutrition. They could do everything possible to mount massive actions that can clearly succeed and that can be implemented by communities themselves.

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The silent emergency

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