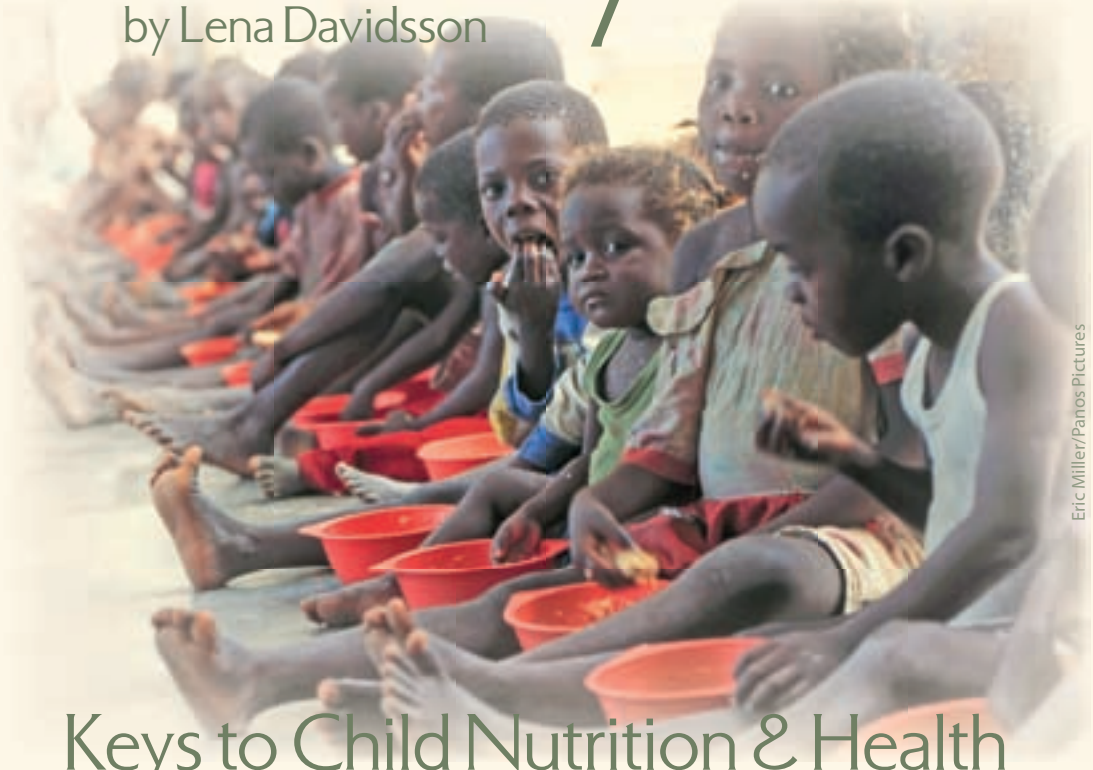
The Early Years

by Lena Davidsson



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Keys to Child Nutrition & Health

Of every ten children born in developing countries, one child will die before his or her fifth birthday. This extremely high death toll — in total more than 10 million young children die in developing countries each year — demonstrates the vulnerability of infants and young children to poor nutrition and poor health. The fact is, a large majority of child deaths in developing countries are preventable with a combination of good care, adequate nutrition and appropriate medical treatment. This brings us hope that the unacceptably high childhood mortality can be reduced with effective interventions, and is reflected by the Millennium Development Goals (MDGs) which include the call to reduce by two-thirds the mortality rate among children under five years of age.

The importance of adequate nutrition during early life cannot be underestimated. Infants and young children have high requirements of energy and nutrients due to rapid growth and development. During the first few years of life, children are particularly vulnerable to the negative health effects of undernutrition. In addition, poor health and undernutrition often overlap in young children.

The relationship between undernutrition and morbidity is complex as illness often results in undernutrition which, in turn, increases susceptibility to infectious disease. Children living in resource-poor areas are thus often caught in a vicious cycle of poor nutrition and infectious disease. For example, undernourished children have increased susceptibility to malaria due to impaired function of the immune system. The impact of undernutrition on the burden of malaria morbidity is demonstrated by estimates made for the World Health Organization (WHO) Comparative Risk Assessment project. These estimates indicate that over 50% of malaria deaths in children under five years of age (i.e., more than 500, 000 children per year) are attributable to undernutrition, defined as low body weight for age.

Combatting Undernutrition

Four of the eight Millennium Development Goals highlight the importance of adequate nutrition for human health and development. The IAEA is assisting Member States in their efforts to achieve these goals by providing technical support for strategies to combat undernutrition.

In particular, the IAEA contributes technical expertise in the use of stable isotope techniques in the development and evaluation of nutrition interventions. Stable isotope techniques have been used as research tools in nutrition for many years. However, the application of stable isotope techniques in programme development and evaluation is a relatively new approach, where the IAEA has a unique opportunity to contribute. As only stable (non-radioactive) isotopes are

used, the techniques can be applied in the most vulnerable population groups, i.e., infants and children. The use of stable isotope techniques adds value by increasing the sensitivity and specificity of measurements as compared to conventional techniques.

This brief overview highlights selected activities in infant nutrition where stable isotope techniques have been used. They include projects to measure human milk intake in breast-fed infants, lean body mass (muscle mass) in lactating mothers, and bioavailability of iron in infants and young children.

Nutrition During Early Life

Exclusive breastfeeding for six months, followed by the introduction of appropriate complementary foods and continued breastfeeding, as recommended by WHO, are cornerstones in infant nutrition. However, only limited information is available on the quantities of human milk consumed and the time of introduction of other foods into the infants' diet, in particular in developing countries. The lack of information is, at least partly, due to the difficulties involved in measuring intake of human milk.

By conventional technique, infants are weighed before and after each feeding, so-called "test weighing". This technique is obviously time consuming and far from accurate as the procedure disturbs the normal feeding pattern. In addition, in many settings, infants are nursed frequently — "on demand" — including during the night, resulting in severe practical limitations to the use of "test weighing".

By using a stable isotope technique, namely the deuterium-oxide turnover method, these practical problems can be overcome. The normal feeding pattern is not influenced and the total volume of human milk, consumed by the baby over a period of 14 days, is measured. Furthermore, the method is non-invasive as the dose of deuterium-oxide is consumed orally by the mother and only samples of urine or saliva are collected for analysis. Briefly, after intake of deuterium-oxide by the mother in a glass of water, deuterium is mixed with the mother's body water and ingested by the baby via human milk.

By measuring the appearance of deuterium in the baby's urine or saliva, intake of human milk can be calculated. Information about whether the infant has consumed water from other sources than human milk can be obtained at the same time and the mother's body water content can be measured. Based on body water content, the mother's lean body mass (muscle mass) can be estimated to provide important information about the nutritional status of the lactating mother.

This method, elegant in its simplicity, has been developed and validated by independent researchers and is currently used in Member States with technical assistance from the IAEA. Important steps in making this technique more widely available, and to build up national capacities, include regional training courses, fellowships and expert visits as well as the procurement of laboratory equipment.

Within the IAEA's technical cooperation projects in Ethiopia, Senegal, Ghana, Chile and Brazil, the deuterium-oxide turnover technique has been used. The aim has been to measure intake of human milk in breastfed infants to develop and evaluate nutrition interventions, based on local conditions.

In addition, in some of these national projects, information about lactating mothers' body composition has also been collected. For example, data from Senegal demonstrated that although human milk intake was not higher in infants born to mothers benefiting from a supplementary feeding program during pregnancy, there was a significant increase in muscle mass in mothers who were supplemented for more than 60 days.

In developing countries, of every ten children born, one dies before his or her fifth birthday. This extremely high death toll demonstrates the vulnerability of infants and young children to poor nutrition and poor health.

It is noticeable that no difference could be detected by conventional techniques used to evaluate nutritional status, based on body weight and height. These results clearly highlight the added value of using the deuterium-oxide turnover method when evaluating impact of nutrition interventions during pregnancy and/or lactation in mothers and babies.

Although the benefits of exclusive breastfeeding during the first six months of life are widely recognized, many mothers introduce other fluids and/or foods at an early age, due to a number of reasons. In many settings, infants are given water, tea, or honey very early in life. Babies are therefore unfortunately often exposed to bacteria and viruses resulting in diarrhea and other infectious diseases.

Accurate information about the amounts of foods and/or fluids consumed by breastfed infants is practically impossible to obtain by conventional techniques. It is thus important to note that in addition to information about human milk intake, data based on the deuterium-oxide turnover

technique can also provide information about whether an infant is exclusively breastfed or if he/she is consuming water from other sources. Projects in Senegal, Ghana and Brazil have explored this methodological advantage of the technique. For example, results from Brazil and Ghana demonstrated that by providing counselling and education about the benefits of exclusive breastfeeding to lactating mothers, the introduction of other foods and fluids into the diet of infants before six months of age can be delayed and/or the amounts can be minimized.

Infants are very vulnerable to nutritional deficiencies when they are first introduced to complementary foods, which should happen at six months of age according to WHO's recommendation. The gradual increase in energy and nutrients provided by semi-solid/solid foods requires access to appropriate complementary foods with high energy and nutrient density as well as high nutrient bioavailability. In many resource poor areas, homemade, semi-solid foods based on cereals are representative of the monotonous diets consumed by infants and young children. The introduction to complementary foods is of public health concern due to the increased risk of diarrheal disease from contaminated foods and the risk of growth faltering due to poor nutritional quality of the diet.

Hidden Hunger

In addition, the prevalence of micronutrient deficiencies — also called "hidden hunger" — is very high in many developing countries, in particular during early life. Some of the most serious consequences of micronutrient deficiencies during infancy include adverse effects on psychomotor and mental development due to iron deficiency, as well as blindness and increased morbidity and mortality due to clinical vitamin A deficiency. Less severe, but much more common, vitamin A deficiency results in increased morbidity and poor growth in children. Sub-optimal zinc status also limits children's growth and increases morbidity.

Thus, micronutrient deficiencies have major health consequences in early life as adequate micronutrient status is essential for normal growth and development. One of the priority areas for the IAEA's project in human nutrition is to combat micronutrient deficiencies, in particular in infants and young children.

Full-term breast-fed infants generally have adequate iron status during the first six months of life. But after this time, when body stores have been depleted and requirements are high due to rapid growth and development, iron has to be provided by the diet. Therefore, the amount and bioavailability of iron in complementary foods are of special concern.

Iron bioavailability, i.e., the fraction of iron absorbed and utilized by the body, is usually low from cereals and pulses due to the presence of phytic acid, the major phosphorus storage compound, and thus a natural component of cereals and legumes. However, the inhibitory effect of phytic acid on iron bioavailability can be overcome by vitamin C, a potent enhancer of iron absorption present in many fruits, especially citrus fruits. The importance of adding vitamin C to a traditional, homemade complementary food to enhance iron absorption was recently demonstrated in Pakistani infants within an IAEA coordinated research project supporting Ph.D. students in developing countries.

Iron absorption was measured by a stable isotope technique, based on the incorporation of iron stable isotopes into red blood cells in healthy infants consuming a traditional complementary food based on rice and lentils. The results demonstrated that iron absorption can be increased two- to threefold by the addition of vitamin C. It thus indicated how simple dietary modifications can improve the nutritional value of homemade complementary foods.

Centrally produced complementary foods usually contain added vitamin C as well as added iron, i.e., these products are fortified with nutrients to increase the nutritional value of the foods. However, as iron bioavailability varies widely between different iron compounds, measurements of iron absorption are important steps in the development of effective food fortification strategies. For example, iron bioavailability from three different iron compounds added to a milk-based complementary food used in a nutrition program targeted at young children in Mexico was recently compared in young children, by stable isotope technique, and provided guidance on how to optimize the nutritional impact of the intervention.

"The Child Cannot Wait..."

The urgent need for effective nutrition interventions to combat undernutrition during early life cannot be more elegantly — or more forcefully — summarized than by the Nobel Prize laureate, Gabriela Mistral: "Many things we need can wait, the child cannot. Now is the time his bones are being formed, his blood is being made, his mind is being developed. To him we cannot say tomorrow. His name is today."

IAEA activities in human nutrition contribute to the achievement of the Millennium Development Goal to reduce by two-thirds the mortality rate among children under five years of age. The IAEA provides technical support to Member States in the application of stable isotope techniques to optimize nutrition interventions for improving the nutrition, health and well being of infants and young children in resource poor areas.

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