

Five decades of
International Nutrition
Research and Advocacy

Conducted by
Professor Michael Latham
and his
Cornell University Colleagues and Students

Edited by
Micheline Beaudry
Suzanne Gervais and
Michael Latham

With contributions by
Andrea Gaul
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Preface and acknowledgements

This Monograph was first conceived and proposed by four organizers of the 2008 Cornell International Nutrition Alums Reunion (CINAR) - Juan Aguilar, Micheline Beaudry, Jeanne Lawless and Suzanne Gervais. They suggested in a somewhat light, even casual way: “Would it not be interesting, and great, if we could produce a written summary covering the over 400 published articles coming out of the 40 plus years of research you have done with your colleagues and former students?” That, at first glance, did not seem, then, the daunting task it became.

The publications from some others’ laboratories or academic research groups often focus on one research question, or mainly on one particular nutrient. Ten different topics are covered in this Monograph in 11 chapters. Each chapter title may suggest one research question. However, most chapters cover a broad range of research and advocacy which often involve work in several countries. These 11 chapters attempt to outline the research of Michael and his colleagues, and some of his advocacy. These are taken from some 468 published papers and books in which Michael is first author, or one of the authors. Each chapter has its own reference list but includes a total of only 169 of these 468 publications. So even though the Monograph is 191 pages in length, there are many research papers that are not included in the Monograph.

I would not have undertaken the task without, very early on, having a group of undergraduates who played a major role first in reviewing particular parts of the published papers; then often producing summaries; and later placing conclusions in a broader context, beyond the Cornell research. All of these talented Cornell undergraduates are members of the very large Cornell Undergraduate Society “Cornell Health International”, for which I serve as Faculty Advisor. Many of the undergraduates worked on this for credit under the course NS 666 -- Topics in Nutrition. Five of them had been among a group that was to spend the winter break working in Kenya and had attended a Fall 2007 evening course for which I was the Instructor.

My gratitude goes to these intelligent and hard working young people who, with some faculty, are authors of the Monograph. These are Andrea Gaul, Katherine Huong, Antony Kironji, Kathryn Mosso, Jian Tian, Betsy Worderly, Annie Kearns, Yuliya Tipograf and Julie Grimaldi. Dr. Jeanne Lawless, a faculty member, one of the CINAR organizing group, and a former student of Michael’s, produced the first draft of chapter 10.

In the early stages, Dr Micheline Beaudry and Dr Suzanne Gervais were enormously helpful with the Monograph goading me, advising the undergraduates and others to move forward chapter by chapter. Most of the first very rough unedited draft, with some incomplete chapters, was ready for alums to see at the time of the CINAR gathering in July 2008. Then came the mammoth task of editing the text and checking and synchronizing the references. I am enormously grateful to Dr Micheline Beaudry for doing the lion’s share of this work, spending huge numbers of hours on it, and doing a splendid job.

Typing of some of the first chapters was done by Jessica Poliandro from Sound Secretarial Services in Florida. In Ithaca, typing, and much other help, has been attentively and wonderfully provided by Barbara Seely who for so many years was a vital staff member of the Division of Nutritional Sciences and who was much missed by many of us when she left.

Those contributing to the original research publications are recognized mainly in that their names appear as authors or co-authors in the references for the 11 chapters. But it is important to recognize that to conduct research in other countries, local collaborators are vital and play an enormous role. Three among many countries in which we have worked extensively are Kenya, the Philippines and Tanzania. I wish to acknowledge the great assistance of Dr. Stephen Kinoti in Kenya, Dr. Florentino Solon in the Philippines, and Dr. Godwin Ndossi and Dr. Simon Tatala in Tanzania.

Finally I want to acknowledge the huge contribution of Dr. Lani Stephenson to much of my work at Cornell. She has for over 35 years been my mate, my colleague and my best friend. Chapter 3 covers in some detail her very important contribution to the topic of the impact of certain highly prevalent parasitic infections on nutritional status. Chapter 9 summarizes some of her important contributions to scientific knowledge regarding lactose intolerance. In much of this work over many years, she was often the Principal Investigator.

Thanks everyone who helped.

Michael Latham

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Chapter 1 - Introduction

This report is intended to highlight the research conducted over 40 years by Michael Latham and many of his colleagues and graduate students while at Cornell University. It is produced, in part, on the occasion of a reunion to recognize Michael's 40 years as a full professor at Cornell, 25 of which he served as Director of Cornell's Program in International Nutrition, as well as his 80th birthday. Many people contributed to its preparation, reviewing and summarizing works among some 450 publications in which Michael is author or co-author. These publications actually began prior to his arrival at Cornell and this first chapter addresses this earlier work which led him to Cornell in 1968.

Much of this body of earlier work was done in Tanzania where Michael was born and where he worked from 1954-1964. His very first publication in 1960, *Malnutrition as a cause of anemia in children*, was based on some of his work as a District Medical Officer (Latham 1960). He had investigated the comparative impact on hemoglobin of iron supplementation, malaria prophylaxis, hookworm treatment, a dietary milk/meat powder supplement and a placebo. The dietary supplement produced the greatest hemoglobin rise. The conclusion reached at the time, that the protein from the milk/meat powder was responsible for this result, was probably wrong. With present knowledge, it is more likely that it was due to the heme iron from the meat powder. Yet, half a century later, it is probably true that we are not certain of the relationship between low protein intakes and anemia.

In Tanzania, Michael was the first to conduct a goitre survey. He reported that, in the Ukinga Highlands, over 75 % of adults and children had goitre (Latham 1965a; Latham 1966a), the highest prevalence ever reported in Africa. The research continued to investigate the etiology of goitre. It was concluded that the high dietary intake of goitrogens in cabbage was not a factor, and that the goitre responded well to small amounts of medicinal iodine (Latham 1965b).

Michael also studied the neuropathy occurring in prisoners at the large Ukonga Prison in Dar es Salaam showing that the cause was dietary and due to a deficiency of B vitamins, probably mainly thiamine and pantothenic acid (Latham 1964a). The subjects had ataxia, difficulty walking and often optic neuritis. Many years later this research caught the attention of physicians in Cuba, and in PAHO, when the blockaded island had a very large outbreak of a somewhat similar neuropathy. In Cuban subjects, the manifestations again were ataxia plus serious eye signs. Experts in Cuba as well as those from WHO and CDC, were not certain whether the cause was a viral infection or whether it was related to the consumption of methyl alcohol in some rum, to cyanide intake from cassava, to tobacco smoking, or to some other cause. This led to Michael being invited to a four day conference in Havana to help determine the cause, a meeting at which President Fidel Castro fully participated, sitting in the audience each day. Michael shared his findings from the neuropathy in Tanzania. It was eventually widely concluded that the Cuban neuropathy was also due to vitamin B deficiencies (Latham 1996).

In Tanzania, with other colleagues, Michael introduced what would later be called an Applied Nutrition Program (ANP), or in the 1990s, a Joint Nutrition Support Program. From 1958 to 1961, district level professionals from agriculture, community development, education, health, and others, along with local leaders, implemented a broad range of activities to address the very prevalent malnutrition in Songea District (Robson, Carpenter, Latham and Lewis 1962; Latham 1963a). Later he worked with FAO in Rome and authored the FAO book *Planning and Evaluation of Applied Nutrition Programs* (Latham 1972).

In northern Tanzania, Michael conducted studies on the implications of high intakes of naturally occurring fluoride in water. Very high rates of dental fluorosis were observed, 75 % in children, 86 % in adults (Grech and Latham 1964; Latham 1966b; Latham and Grech 1966), as well as extensive, sometimes crippling, skeletal fluorosis, mainly in older people (Latham and Grech 1966). Interestingly these publications prompted the strong opponents of water fluoridation in the United States to invite him to testify at various hearings trying to prevent city or regional plans to fluoridate water. They were surprised when he strongly supported fluoridation of municipal water supplies as a means to “adjust fluoride levels to those that were safe and that greatly reduced dental caries”.

While in Tanzania, Michael and his colleagues conducted several studies on school feeding (Latham 1963b; Latham and Robson 1965). The results showing significant improvement in nutritional status are still often quoted. He conducted several nutrition surveys including in famine areas (Latham 1964b) and in a major flooded area in Rufiji District (Latham 1963c). He also produced numerous papers on the nutritional problems in Tanzania and their potential solutions (Latham 1963a; Latham 1964c; Latham 1966c; Latham and Stare 1967). This work culminated in an invitation by FAO, UNICEF and WHO to produce a manual on nutrition for Africa. The resulting 260 page book, *Human Nutrition in Tropical Africa*, went into three editions and 11 printings, in both English and French, and became an FAO best seller (Latham 1965c). The publisher, Longmans Green, then commissioned Michael’s next book written for teachers and communities, *Nutrition in Eastern Africa* (Latham and Baker-Jones 1966).

In numerous publications based on the work in Tanzania, Michael was early in drawing attention to topics such as the risks from aflatoxin in groundnuts (Latham 1964d; Latham and Stare 1967); the promotion by corporations of infant formula to replace breastfeeding in African babies (Latham 1963a; Latham and Stare 1967); the problems of low birth weights (Latham and Robson 1966); the importance of horticultural crops (Latham 1966d); the nutritional implications of unavailable family planning; and the potential benefits of the wide use of Intrauterine Contraceptive Devices (IUDs) (Latham 1966e).

In early 1964, Michael left his position as Director of the Nutrition Unit of the Ministry of Health in Tanzania. He spent 6 months at his house in Sussex in the UK to complete the FAO/WHO/UNICEF book before taking an appointment as a Research Fellow at the Harvard University School of Public Health. He completed the MPH degree at Harvard in 1965 where he remained as a Research Associate in 1965 and an Assistant Professor from 1966 to July 1968. This is when he was appointed full Professor of International Nutrition in the then Graduate School of Nutrition at Cornell University.

While at Harvard, he became the head of the famed Ireland-Boston Brothers Heart Study. This was one of the very early studies of diet and heart disease. Irish born men between 30 and 65 years of age were recruited in Boston. All had a consenting brother in the same age range still living in Ireland (Brown, Latham, Hegsted, Jessop *et al.* 1970). The study was designed in part to get around the evidence at that time suggesting important racial and hereditary differences in heart disease rates and in risk factors. A total of 1154 brothers were enrolled. Most of the Irish brothers were rural farm workers whereas most Boston brothers worked and lived in an urban area. Because of this, a separate group of 312 urban workers in Dublin were also recruited. Separately, coronary arteries and aortas were collected in Ireland, and from Irish subjects in Boston coming to autopsy, to determine atherosclerotic involvement. The two groups did not differ significantly in the proportion of energy from fat and saturated fat, in the serum cholesterol and blood pressure levels, or in the amount of cigarette smoking. However, the Irish subjects had higher intakes of energy and complex carbohydrates; yet lower weight, skin fold thickness and percentage of abnormal electrocardiograms than the Boston men. The autopsy results showed much earlier serious atherosclerosis in the aortas and coronary arteries in Boston men. Increased physical activity was very important in reducing the risk of coronary heart disease (CHD) in the subjects in Ireland. This was the first ever study to point to the lack of exercise as being perhaps the most important risk factor in CHD, even more important than diet.

While at Harvard, Michael was also involved in designing a very large National Institutes of Health (NIH) study to be conducted in Colombia to investigate the impact of malnutrition on mental development (Latham, Cobos, Rueda-Williamson and Stare 1969). Over the next several years he authored over 15 articles on this topic in journals such as the *American Journal of Public Health* (Latham and Cobos 1971), *Preventive Medicine* (Cobos, Latham and Stare 1972) and *Physiological Reviews* (Latham 1974). From all the work by this group, and that of numerous others over many years up to the present, we can conclude that malnutrition is significantly associated with lower cognitive development, and that this is also associated with poverty, ill health and poorer child care.

Still at Harvard, Michael took a leading role and became first author of a book designed to educate medical students and physicians about nutrition (Latham, McGandy and Stare 1970). A copy of this *Scope Manual on Nutrition* published by Upjohn was given to every medical and dental student in the United States in 1971, and for some years thereafter. This highly illustrated book was reprinted six times before going into a second edition in 1980. In the summers of 1966 and 1967, Michael was also responsible for a Harvard program which recruited second year medical students who attended his International Nutrition course; he then accompanied them in their field research project in Colombia. Two of these students went on to important nutrition-related careers: Noel Solomons in Guatemala and Kenneth Rothman with his renowned and much-used textbooks in epidemiology.

Michael came to Cornell in July 1968 to become Professor of International Nutrition, then the only such professorship in the United States. He was appointed full professor at age 39, after only 4 years in academia, but well published mainly due to research conducted in Tanzania. He replaced Andre van Veen, a food technologist with a distinguished career. Andre van Veen had worked before World War II as Director of the Eijkman Institute in

what is now Indonesia; he had been a Japanese prisoner of war for 4 years, worked with FAO in Rome in its early years and, at Cornell, continued laboratory work on Indonesian fermented foods while also introducing social dimensions to field work in international nutrition.

The position of Professor of International Nutrition was in Cornell's Graduate School of Nutrition, which has since been incorporated in the Division of Nutritional Sciences (DNS). This New York State supported position is a tribute to the foresight of Dr. Richard Barnes, then the Dean. When Michael arrived at Cornell, International Nutrition was a one-man band. At that stage no Cornell student in nutrition had yet done a Ph.D. based on work overseas. The Dean was surprised when in 1968 Michael stated that he did not need a laboratory in Savage Hall, as he expected his "laboratory would be in Africa and in the developing world". Before the end of his first year at Cornell, his first Cornell Ph.D. student was planning her research to be conducted in Haiti and Guatemala, and his two Master's degree students were doing field research in Colombia. The rest of the expansion of International Nutrition at Cornell is now history, with hundreds of graduate students having done research in developing countries for their Ph.D. degree.

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Chapter 2 – Malnutrition, undernutrition Hunger, poor child growth and protein-energy malnutrition

Introduction

Michael wrote the chapter on Protein-Energy Malnutrition (PEM) in the authoritative ILSI/Nutrition Foundation book *Present Knowledge in Nutrition* (Latham 1990). The concluding summary states:

PEM is the most important nutritional problem of children in non-industrialized countries. PEM may occur at any age but is most prevalent in early childhood when it contributes importantly to high rates of morbidity and mortality. The main cause is a lack of adequate food intake, but infections also play an important role in the etiology of PEM. Underlying causes include poverty, inequity in food distribution, and unsanitary living conditions. UNICEF in its 1988 *State of the World's Children* suggested that the monetary debt crisis for many poor nations is contributing to an increase of PEM in children. Kwashiorkor, marasmic kwashiorkor and nutritional marasmus are the severe clinical manifestations of PEM but are much less prevalent than mild or moderate PEM, which in many countries may affect more than 50 % of all children at some time in their lives. This form of PEM is assessed by anthropometric measurements, which are also useful in separating wasted from stunted children (Latham 1990).

The term PEM currently seems out of favor and to be much less used. It is now more common to write about children with undernutrition, and UN literature often uses the term “hunger” as a proxy for malnutrition. So the UN Millennium Development Goals talk of “halving hunger by the year 2015” (Sachs 2005). The MDGs’ focus on halving hunger is laudable, though the actions proposed largely target agricultural and other means of increasing food availability. The use of the term “hunger” as a proxy for undernutrition and poor growth of children may have contributed to the narrow MDG food based focus. When hunger is used as meaning “an uneasy sensation caused by want of food”, this focus on food and agriculture “may reduce the percentage of people who go to bed hungry” (Latham 2008). However, the MDG reports also use the term “hunger” as a proxy for malnutrition. Their maps of “hunger hot spots” are based entirely on prevalence rates of underweight children. This form of malnutrition is not only due to a problem of food availability and lack of food security. It is due often to childhood health problems, to lack of good child care, and to poor appetite. Civil society, national governments, and all who are working to “halve hunger” need to appreciate that, while lack of food contributes importantly to malnutrition, other causes including infections and other diseases, are vitally important, and need to be addressed. If we are to markedly reduce malnutrition using a human rights approach, it is necessary to not only concentrate on food security, but to also reduce the burden of common infections which contribute to hunger and malnutrition. But overall, inequity is the major cause of malnutrition in the world – the rich get richer and the poor remain poor. It is not only due to a broadening inequity in incomes, but also in available healthcare, educational opportunities, safe water and sanitation, housing, and more.

Classification of malnutrition using child growth

For the past many years, when describing the extent of malnutrition in a population, international nutritionists, as well as agencies such as UNICEF and WHO, have divided undernourished children into those who are:

- Underweight
- Stunted, or
- Wasted

This was not always so. Up until the mid 1970s prevalence rates of malnutrition were based entirely on the child's weight-for-age. Commonly used was the Gomez classification of first, second, and third degree malnutrition based on the child's percentage of weight-for-age according to growth standards. In 1967, at a major conference on *Calorie deficiencies and protein deficiencies* held at Cambridge University in the UK, Michael raised doubts about this classification system (Latham 1968). He wrote about the importance of distinguishing between what he termed "acute" *versus* "chronic" malnutrition.

In childhood-malnutrition it is often important to know whether the nutritional deficiency is of long standing or whether the child has only comparatively recently been deprived of an adequate diet. A child who is suddenly starved or severely deprived nutritionally can very rapidly lose a great proportion of his body weight, but he cannot lose height. Acute malnutrition, therefore, results in a child who, though greatly underweight, is only slightly shorter than his expected height-for-age. In contrast, a child who has a large deficit in height or length has usually endured a prolonged dietary deficiency and suffers from chronic malnutrition. It is important to distinguish these varieties of malnutrition because the public health solution may vary according to the prevalence of each.

It was proposed in this publication that on the basis of measurements of both weight and height, and knowing the age, malnourished children could usefully be divided into three groups termed acute malnutrition, chronic malnutrition, and acute on chronic malnutrition. Some years later the terminology became wasting, stunting and, wasting and stunting.

The first field test of the utility of this new classification was conducted in Bogotá in Colombia (Seoane and Latham 1971) in the barrio of San Carlos, where a study of the impact of nutrition on intellectual development was underway (Latham, Cobos, Rueda-Williamson and Stare 1969). A total of 787 children under 4.5 years of age were included. Measurements were made of height, weight, triceps skinfold thickness, arm circumference, chest circumference, and head circumference. It was concluded that dividing malnourished children into these three different groups (acute, chronic, and acute on chronic) was feasible and useful. The paper concludes "it seems important to make a distinction between the child" who is currently malnourished and the child who has anthropometric stigma of past malnutrition (Seoane and Latham 1971).

These findings caught the attention of Professor John Waterlow who in the 1970s was considered the "guru" in research on what was then termed protein-calorie malnutrition. In an important article in the *British Medical Journal* entitled *Classification and definition of protein-calorie malnutrition* he wrote:

As Seoane and Latham pointed out, weigh-for-height is an index for current nutritional status; height-for-age gives a picture of the past nutritional history. Since these parameters measure different things it is desirable that changes in them should be distinguished by different words (Waterlow 1972).

Waterlow went on to suggest “four categories” of malnutrition which are qualitatively different:

- Normal
- Malnourished but not retarded – that is acute malnutrition
- Malnourished and retarded – that is acute on chronic malnutrition
- Retarded but not malnourished – the so called nutritional dwarf.

He proceeded to arrange an important session at the International Congress on Tropical Medicine and Malaria in Athens, Greece, from 14-21 October 1973, to try and reach some agreement on these classifications. He invited Michael to produce a paper and to be the lead speaker. The paper was entitled *A method to distinguish between current acute and past chronic protein calorie malnutrition* (Latham 1973). In this presentation, the use of the proposed classification was extended beyond the Bogotá data to findings from the FAO survey in Zambia, on which Michael had worked, and to data from a small group of children he had assessed in Nigeria who were severely affected by the so called “Biafran War”. Zambia, like most peaceful African countries, showed a great deal of chronic malnutrition whereas the Nigerian children had a great deal of acute malnutrition.

The new classification clearly illustrated its validity, which importantly could influence appropriate action. Acutely malnourished Nigerian children who were wasted but not stunted would benefit rapidly from food intervention. This is in contrast to, for example, 5 year old Zambian children who were stunted but not wasted. Feeding 5 year old stunted children who are not wasted would not be expected to result in much gain in height. Waterlow and others at the Athens conference agreed that a classification of PEM based on weight and height measurements of children when age was known, use three categories of underweight children which came to be known as wasting, stunting, and wasting and stunting.

A further proposal to consider a new means of evaluation using the actual weight and height of children, although attractive, has not been much accepted (Stephenson, Latham and Jansen 1983). This proposed a system similar to that used by psychologists to express deficits in development in terms of years (or months). Psychologists may state for example that the IQ of a 6 year old is that of a 4 year old. The proposal related to weight and height deficits was to state, for example, that a 36 month old child has the weight of a 30 month old and the height of a 28 month old using the 50th centile of growth standards.

This new method was tested and forms part of a 109 page monograph entitled *A comparison of growth standards: similarities between NCHS, Harvard, Denver and Privileged African Children and Differences with rural African children* (Stephenson, Latham and Jansen 1983). This landmark publication became very widely consulted. It also

- reported in great detail the physical growth of a large group of rural Kenyan children living in Machakos District;

- compared the growth of this population of Kenyan children with different sets of reference values for growth which have been derived from predominantly Caucasian (white) or East African Bantu (black) populations;
- compared different commonly used sets of growth references with each other.

Conclusions from this research strongly supported the view that ethnic differences are very much less important than other factors as causes of growth failure in children. In East Africa, poor growth in children appears to be a feature of poverty, deprivation, and disease, rather than ethnicity. The data show that East African children who are raised in a good environment by educated parents, are provided with adequate diets, and receive good health care, appear to grow similarly to North American children. The WHO published references, the NCHS, Harvard and Denver references for weight and height, were shown to have only small differences and a high degree of similarity. Those small differences may be important for research but not for programmatic purposes.

Contribution of nutrition to child mortality

It is now generally accepted, including by WHO, that close to 50 % of child deaths in developing countries are due to malnutrition – not overt nutritional diseases, but often mild or moderate malnutrition contributing to death from respiratory infections, diarrhea, malaria, measles, and other causes. Up until about 1990, it was widely believed that it was almost entirely severe malnutrition that contributed to the risk of child mortality (Chen, Chowdhury and Huffman 1980). What served to change this conclusion?

A study in the Iringa Region of Tanzania was begun in 1975 by Olivia Yambi, as a Ph.D. dissertation (Yambi 1980), to assess the relationship between the anthropometric indicators (weight-for-age, height-for-age, and weight-for-height, as well as weight increment) and subsequent mortality. Anthropometric measurements were taken on 2452 children between 6 and 36 months of age at the baseline and then at 2 month intervals thereafter. The children were followed for 1 year. All deaths occurring in this group were recorded. The results showed that over the 12 month period, nutritional status was a significant predictor of mortality. Low weight-for-age was associated with a nine-fold increase in mortality, low weight-for-height with a four-fold increase, and low height-for-age with a two-fold increase. Most importantly, an overall linear relationship was found between nutritional status and mortality, suggesting a gradual increase in mortality as nutritional status deteriorates (Yambi, Latham, Habicht and Haas 1991).

This important study, and a half dozen subsequent ones, led to the landmark conclusion that even if a child is only moderately malnourished the mortality risk is increased (Pelletier, Frongillo, Schroeder and Habicht 1994). The great significance of all this research is that, because the prevalence of mild to moderate malnutrition is very high, it contributes to a very large proportion (around 50 %) of all child deaths worldwide.

Nutrition rehabilitation centers

The concept of Nutrition rehabilitation centers (NRCs) was originally proposed in 1955 (Bengoa 1955). This constituted an important attempt to move emphasis from

kwashiorkor and nutritional marasmus, and their treatment, to prevention. Many children with moderate malnutrition remained untreated and often lapsed into severe malnutrition, often requiring expensive hospitalization, and frequently with high fatality rates.

NRCs, sometimes called Mothercraft centers, are often designed to function somewhat like a day care center. They however differ in that selection of children is based mainly on nutritional criteria, the length of attendance is limited to that necessary to nutritionally rehabilitate the child, and a very important objective is nutrition education of the mother. In the 1960s large numbers of NRCs were established in many countries in Asia, the Caribbean, Latin America, and Africa. Claims were being made in the late 1960s that “NRCs are our most encouraging answer to malnutrition”; the press was generalizing to conclude that “these centers offer a complete solution and at a bargain price”. Reports appeared stating that NRCs were offering a “miracle”. Yet no good evaluation had been done.

This void was filled with a detailed evaluation of the performance of NRCs in Haiti and Guatemala (Beaudry-Darisme and Latham 1973). This unusually long journal article (33 pages) proved to be a landmark. The research sought to be an objective evaluation of NRCs, not only in terms of the progress made by children while attending the centers, but also on how these children progress at home in the months after discharge, and on the knowledge and practices of mothers who participated in the center programs. The research was conducted by Micheline Beaudry for her Cornell Ph.D. dissertation in seven NRCs in Haiti and nine in Guatemala.

The mean NRC cost per child per day was US .37 cents in Haiti and US .88 cents in Guatemala, very much cheaper than hospital costs for treatment of severe malnutrition in these countries. The important conclusions stated that the NRCs in both countries were “having a favorable effect on the growth of most children while they are being regularly fed at the center, but are having a rather small effect on those children after they return home”. There were many reasons for this, perhaps the most important of which is that “the education of mothers is not as effective as might be hoped”. This is likely because (a) staff give much more attention to feeding and caring for the children than to education of their mothers, (b) the nutrition and health education is often unrealistic in terms of what is feasible in the homes, and (c) a significant proportion of families using the center are too poor to make the necessary improvements in the diets of their children.

In the years since this evaluation, there has been a very major decline in the numbers of NRCs in developing countries and on reliance on NRCs as a major action in the fight to reduce malnutrition.

Growth monitoring and promotion

This “story” on growth monitoring (GM) began for Michael in 1966, when he first read David Morley’s pioneering original descriptions of the use of the Ilesha growth chart in Nigeria (Morley 1968). As a contributing Editor, he then wrote an anonymous editorial review on Morley’s work for the journal *Nutrition Reviews*. His interest in GM has remained to the present day and he has written extensively on the topic.

The important research to evaluate growth monitoring described in the following pages was conducted by Sabu George as part of his Cornell Ph.D. dissertation. It required 4 years of dogged field work in India which was carried out under Michael's direction and assisted by staff at the Christian Medical College in Vellore. This culminated in our important article in the *Lancet* (George, Latham, Abel, Ethirajan *et al.* 1993).

This actual evaluation of the use of the growth chart was complemented by important work, again in India, and also by Michael's Ph.D. student, this time Meera Shekar. She investigated in detail the very large Tamil Nadu Integrated Nutrition Project (TINP) where the growth chart was used, but unusually was complemented by major efforts and activities aimed to promote good growth of children enrolled.

The story here includes summaries of the research by Sabu George and Meera Shekar, but also the prior and subsequent writings by Michael on GMP, and the important conferences on the topic to which he contributed.

For most of the last 4 decades, growth monitoring (GM) of children has been practiced (Latham 1979), and in some countries GM constitutes the major intervention to reduce malnutrition. It is often supported by UN and bilateral agencies, by international NGOs, and by national governments. It is part of many of the heavily funded World Bank nutrition programs such as those in Bangladesh and Uganda. There are, of course, many other actions that donors and governments have supported to promote better growth of children (Latham 1984). However, concentration on support for GM, including the provision of weighing scales and growth charts, and funding for programs to assist widespread weighing and charting, has often remained a priority.

Most accept that the GM movement began with the early work of David Morley in Nigeria leading to the use of the innovative Ilesha growth chart (Morley 1968). Prior to that, of course, pediatricians in many countries were having babies weighed and then followed their weight gain. Morley stressed the use of the chart to promote growth, not to cure malnutrition.

In the second edition of *Human Nutrition in Tropical Africa*, Michael wrote at length about the use of these growth charts by health workers, emphasizing the need for growth promotion to accompany growth monitoring – hence the “P” in “GMP” (Latham 1979). He suggested five operational rules for successful growth monitoring and promotion (GMP). They can be summarized as follows:

- Infants should be enrolled in GMP as soon after birth as possible, because much of growth faltering begins in the first 12 months of life. So children enrolled in their third year (or even second year) will often have evidence of growth failure that is difficult to reverse, especially in children who are stunted but not wasted.
- The health worker doing the weighing and charting needs to have adequate time for a dialogue with the mother (perhaps 10-15 minutes), good communication skills, and a knowledge both of factors likely to contribute to growth failure in children in the community and of feasible suggestions for action that can be given as friendly sensible advice.

- GMP should be integrated into primary health care (PHC). This is desirable because some of the advice given is likely to involve PHC (immunizations, ORT, family planning, etc.).
- Advice given should, as far as possible, be rather specific, but provided as part of a dialogue that helps empower the mother to assist good growth in her child.
- GMP should be conducted in a way to make it most acceptable to the mothers, for example at times and locations most convenient for parents, rather than health workers (Latham 1979).

In his chapter from the important book edited by James Hines, Michael (Latham 1991) expanded on his assessment of the limitations of practicing only “growth monitoring” (GM):

The recording of a child’s weight on a growth chart itself serves no useful purpose unless accompanied by some action. This has long been recognized, but in many growth monitoring programs this is about all that is done. Under these circumstances the potential benefits of growth monitoring are not, and cannot, be realized. Growth monitoring, then, is a strategy to empower mothers to maintain good nutritional status in their children and to prevent growth retardation. Much of the action should consist of positive reinforcement rather than corrective action. As a diagnostic exercise it should be as much to find out what mothers are doing right as what is going wrong.

In all cases meaningful involvement of mothers should be the heart of a growth monitoring and promotion program. It is a participatory exercise; it involves dialogue and discussion, not lecturing and scolding; and mothers should help in decision making, for example, about the location, the hours and the organization of GM sessions.

These views of growth monitoring and promotion present the concept of the author, and of others, of how it should be practiced, rather than what usually happens in countries in Africa, Asia, and Latin America. Michael continues to see growth monitoring in action, which ignores these principles. He has reported that, traveling to many countries on all three continents, it was very common that few of these operational guidelines were followed. Too often growth monitoring is used mainly as a weighing exercise, advice is given only to mothers whose children are doing badly, and this often consists of public scolding.

In the 1980s and subsequently, this rather simple appearing intervention of GMP became mired in international debate with strong proponents and opponents. The literature on growth monitoring mushroomed, but almost all of this was in the form of opinions rather than evidence based. This became even more relevant as GM became the action in UNICEF’s strongly supported and influential four pronged so called GOBI strategy standing for growth monitoring, oral rehydration, breastfeeding and immunization (Grant 1985). Again UNICEF was advocating growth monitoring as an effective, simple, and inexpensive way to prevent most child malnutrition. But this was being questioned because of the lack of evidence that growth charts are a better educational tool than health and nutrition education without growth charts (Gopalan and Chatterjee 1985). There seemed to be little appreciation, certainly in the field, that the wide practice of GM had really not been well evaluated in

terms of its impact on the growth of children. In many countries, and in the programs of many international agencies, so called “evaluation”, often leading to conclusions of “success”, consisted in reporting statistics mainly on numbers and percentages of children attending, and on the frequency of weighing and charting in communities or populations.

In 1985, Michael received funding from the Thrasher Fund, and elsewhere, to allow Sabu George to begin the important field work for an evaluation of the effectiveness of good growth monitoring in Tamil Nadu, India (George, Latham, Abel, Ethirajan *et al.* 1993). The main part of the study was conducted in 12 intervention villages in the K V Kuppam Block, in collaboration with the Christian Medical College and Hospital in Vellore¹. The 12 study villages were non-adjoining poor agricultural communities, each with a population of about 13,000. Growth monitoring had not been conducted in the villages before. Data showed that 70 % of families lived in mud huts with one or two rooms, about 99.5 % defecated in fields (not in a latrine), and fewer than 0.5 % had kerosene or gas stoves.

The 12 villages were divided into six “growth-monitoring package” of interventions (GMP) villages and six “non-growth-monitoring package” of interventions (NGM) villages. NGM villages received the same interventions as GMP villages except for the growth monitoring. Data, including anthropometric measurements, were obtained by trained field workers, not by the nutrition worker responsible for the interventions. Baseline data were obtained from interviews with 1115 mothers who had 1634 preschool children born between April 1982 and May 1988. Children were weighed in all the villages in April 1987 to ascertain the willingness of the communities to accept weighing. Baseline and final anthropometric measurements were done in July 1987 and December 1989, and intermediate anthropometric assessments were done every 4 to 5 months. The take-up rate was about 90 %. Information on socioeconomic status was collected in August 1989. Interventions were provided to both GMP and NGM groups.

The nutrition worker visited homes twice a month to provide education on health and nutrition. Educational films were shown in the villages. Immunizations were provided in the village, antenatal services at the rural clinic, and family planning services at the rural hospital. Curative care was provided at weekly rural clinics. If needed, patients were referred to the RUHSA rural hospital or to the teaching hospital in Vellore. Children aged between 1 and 5 years were dewormed with albendazole or pyrantel pamoate about every 4 months. Vegetable and fruit seeds and saplings were distributed for home gardens.

In GMP villages, growth monitoring was done monthly by the nutrition worker in the child’s home to ensure high take-up rates and the best understanding of the growth charts by mothers. Growth charts were used to educate mothers. The growth monitoring was successfully implemented in GMP villages and resulted in correct use of growth charts, good understanding by mothers, and improved growth of children. Nutrition workers visited the households the same number of times and spent the same amount of time with mothers in

¹ Interestingly this college was founded over 100 years ago by one of the first women ever to get a medical degree from Cornell University’s medical school.

NGM and GMP villages. The content of educational messages in both groups was identical but it was imparted to mothers in NGM villages without the use of growth charts. The anthropometric assessments for research purposes were done by an independent set of workers. Neither the nutrition worker nor mothers in NGM villages were informed how their children were growing with respect to weight.

Comparisons were made by calculating monthly gains in weight and stature in the children in both groups in the 12 villages. The significance of differences observed was adjusted for age and gender. After 30 months of interventions, very similar improvements in growth were seen in GMP and NGM children. The interventions seemed to have improved the nutritional status of young children almost equally in both groups of villages. The data showed a lack of additional benefit from growth monitoring over the educational and other interventions which both groups received. The growth charts did not seem to be a better educational tool, than education without the charts.

Though unrelated to the evaluation of GM in the 12 Tamil Nadu villages, an important finding of this project merits attention. It was observed that female infanticide was a serious problem, perhaps affecting about 10 % of newborn girls (George, Miller, Abel and Latham 1993). Sabu George, after completing his Ph.D., returned to India where, for the last 15 years, his work has highlighted the important problems of both female infanticide and more prevalent female feticide (selective abortion of female fetuses). His work has led to vital legislation, including laws which limit the use of ultrasound and other methods to determine fetal gender, but these have proved difficult to enforce.

David Morley, the founder and guru of GM, at a colloquium on growth monitoring where these findings were presented stated that he believed that growth charts were useful for health workers in the clinic, but that mothers failed to understand the growth curve (Morley and Meegan 2001).

Following the research in Tamil Nadu, but before it was published in the *Lancet*, two important meetings were held mainly because this research raised such important questions. The first was a UNICEF sponsored workshop in Nairobi, Kenya in May 1992 to discuss monitoring of growth; and the second was a Colloquium on *Growth Promotion for Child Health* in Nyeri, Kenya, immediately following the workshop. The Colloquium was co-sponsored by the Canadian International Development Agency (CIDA), Cornell University and the Canadian International Development Research Centre (IDRC). The 270 page Proceedings entitled *Growth Promotion for Child Development* reviews almost every aspect of this topic.

George, Latham, Gerein and Cervinskaskas (George, Latham, Gerein and Cervinskaskas 1992) summarized the conclusions from these two Kenya meetings as follows in the *Lancet*:

In your July 18 editorial (p 149) you cite the opinion of the participants at an international colloquium held in Nyeri, Kenya, in May 1992. We were the organizers of that colloquium on growth promotion for child development. We agree that the question raised by the title of a 1985 *Lancet* editorial - *Growth monitoring: intermediate technology or expensive luxury?* – is still relevant. We are pleased that you raise important questions on the current practice of growth monitoring. Our concern, however, is that you tend to equivocate and you cite UNICEF documents

that are now outdated. The Nyeri colloquium was preceded by a UNICEF workshop on monitoring of growth held in Nairobi, in May 1992, which considered the findings of the eight country evaluations on the practice of such monitoring and reached consensus on how to promote the growth of children. At these meetings, it was emphasized that growth monitoring should not be advocated as a global strategy – but nutrition-oriented measures for growth promotion should be. Poorly implemented programmes have sometimes been used as an alibi for not implementing better nutrition strategies. The workshop also recommended that growth monitoring should no longer be promoted as an “entry point” to improve the functioning of health systems. Monitoring of growth has a long history of enthusiastic promotion, and sometimes also of strong advocacy and bloated rhetoric. The Nyeri colloquium was convened because we recognized there was little scientific proof for the effectiveness of this monitoring. The available evidence was reviewed.

The main outcome of the meeting has been included in the Nyeri declaration on growth promotion for child development, which suggests that growth promotion programmes should, almost always, include assessment based on information from the mother, the community, and the health workers. Furthermore, dependent on local conditions and availability of resources, possible strategies were suggested. The declaration emphasized that the information from these assessments should lead to an analysis of the factors influencing growth and this in turn should lead to advice and action.

This analysis would be followed by reassessment, further analysis, and action. One of the strategies chosen might be monitoring of growth, but only if it is culturally acceptable, is likely to be well done by trained and motivated workers who have adequate time and resources, and the mothers and communities are able to participate. You outline reasons why growth monitoring as commonly practiced has not been successful and suggest that “the separate contribution of growth monitoring to the effectiveness of child health programmes” had not been documented. It is true that very little well-designed research to evaluate this monitoring has been conducted. One of the presentations in Nyeri did address this issue.

Meera Shekar’s TINP study

In the 1980s, the Tamil Nadu Integrated Nutrition Project (TINP) provided integrated health and nutritional services to nearly 1 million children in rural south India. In this project, growth monitoring was said to be used as an integrating strategy for providing a range of services including short-term selective supplementary feeding, ORT, immunization, deworming, vitamin A supplements and nutrition counseling. Meera Shekar, in part for her Ph.D. dissertation, conducted a study to delineate the role of growth monitoring and its implementation in TINP. This was not an evaluation of GM, but an attempt to examine carefully an efficient, relatively well designed, very large project where GM was a central focus. The GM part of TINP followed most, but not all, of the suggested operational rules (Latham 1979) for successful GMP. One difference was that it did aim as much to “cure” as to “prevent” malnutrition. It also used selective supplementary feeding.

The results showed that TINP did in general improve the health and nutritional status of young children participating in the project. It cannot definitively be proved that the weighing and charting contributed, or contributed importantly, to the improvement in

nutritional status. The weighing of children was useful in selecting children to receive dietary supplements and for project monitoring (Shekar and Latham 1992).

This research on TINP in India also produced data which allowed an investigation to answer the question “Is positive deviance in growth simply the converse of negative deviance” (Shekar, Habicht and Latham 1991)? The study divided children on the basis of anthropometry into positive deviants (not “malnourished”), and what we called negative deviants (poorly grown), and median growers. The analysis suggests that the mechanisms and factors producing positive and negative deviance are not always opposites, or mirror images of each other.

TINP as investigated by Meera Shekar presents one of the extremely rare GMP projects where growth promotion seemed to be concentrated upon, and weighing and charting were less important and served first for monitoring, and secondly, to select children for supplementation or other special attention.

Conclusions

Despite findings from our research and strong reservations about growth monitoring arising from the UNICEF Nairobi Workshop, as well as from the Nyeri CIDA/IDRC/CU colloquium, nevertheless GMP remains at the heart of many nutrition programs in developing countries.

This failure of funding agencies and countries to take note of the lack of evidence of the effectiveness of GM and the blindness to the views of the scientific community critics led to another major conference in Belgium in 2001 (Latham 2001). Leaders in the field presented papers and led discussions. David Morley, the founder and guru of GM, again stated in his paper there that “Growth Monitoring, although successful in limited NGO situations, could not be shown to have an effect when spread nationally” (Morley and Meegan 2001).

In this conference, Michael, in a paper entitled *Trends in nutrition policy and programmes and how they focus on growth and development* (Latham 2001), wrote:

For over 30 years many of us have been pointing out that interventions were much more likely to reverse malnutrition in wasted children because of the acuteness of the condition, than in stunted children because of its chronicity. But GM using only weight-for-age does not distinguish these two forms of malnutrition (Latham 2001).

He went on to illustrate that we still lacked scientific evidence of the effectiveness of GM.

Serious doubts still remain about the effectiveness of GM as practiced in most countries. In 2003, *Thin on the Ground*, a very critical review of World Bank supported projects in Bangladesh, Uganda and Ethiopia, was published by Save the Children (UK) (Anon 2003). It pointed out the large continued funding of GMP without adequate evaluation. An important conclusion is “We believe these problems arise because the Bank’s core business processes and incentives remain focused on lending money rather than achieving impact”. Michael served as an advisor to Save the Children during the preparation of their publication and during its presentation to the World Bank in Washington, D.C.

Finally the recent Lancet Series on Maternal and Child Undernutrition concluded that growth monitoring showed little or no effect on child undernutrition and stated that “available evidence of growth monitoring was not sufficient to support its use alone” (Bhutta, Ahmed, Blake, Cousens *et al.* 2008).

Nutritional surveillance – a timely warning and intervention system

In the early 1980s, Cornell’s Division of Nutritional Sciences received a substantial grant from USAID (principal investigators J.P. Habicht and M.C. Latham) to work on nutritional surveillance. Dr. John Mason, then at FAO in Rome, came to Cornell to serve as Director of the project. All this emanated from wide agreement that there existed very little information about surveillance in food crises. Nutrition surveillance was defined as a means to watch over nutrition in order to make decisions which lead to improvements in populations.

An early research activity was the development and testing of a timely warning and intervention information system (TWIIS) in Indonesia (Brooks, Abunain, Karyadi, Sumarno *et al.* 1985). In 1980, work commenced on the design of a TWIIS for the *kabupaten* of Central Lombok, an island within the Indonesian archipelago located just east of the island of Bali. Central Lombok is one of the three *kabupatens* on Lombok and has a population of about 600,000. The southern two thirds of Central Lombok consist of non-irrigated rice fields which produce only one crop of rice per year, with planting starting about mid-November and harvesting taking place from March to May. The area is particularly vulnerable to the vagaries of rainfall and has experienced many food crises, and even famine, during the past 50 years.

The immediate goal in Central Lombok was to design a TWIIS which could (a) be operated at low cost by local officials, (b) provide useful information for administrative decision-making, and (c) lead to the implementation of interventions which would alleviate food crises. The information-gathering activity would have to concern data which were, or could be, collected and analyzed by local officials, because referring of information for analysis and decision-making at high levels would inhibit timely intervention in food crises. The TWIIS thus had to be a simple system, capitalizing on the advantage of having local officials who were much closer to the actual food problems, to operate the system.

The first approach to designing this TWIIS was to investigate conditions related to earlier food crises. This included an investigation of food crises during the previous 5 years, preparation of an employment/agricultural calendar, and then development of indicators. During the first 18 months of operation in Central Lombok, the TWIIS was shown to be directly responsible for implementing interventions which helped reduce the adverse impact of food crises. After completion of the nutrition research, the TWIIS continued to function in Central Lombok and similar systems were introduced elsewhere in Indonesia.

The success of TWIIS in Indonesia provides an example of a nutritional surveillance system in which intervention is triggered by certain kinds of information in order to overcome a nutritional problem. The system is designed to be run by local officials who are able to respond quickly and make firsthand investigations of food problems. Furthermore, as

a locally controlled system, it is more likely to be adjusted to account for changes in local conditions.

Nutritional marasmus and kwashiorkor

Protein supplements

In the 1960s and 1970s much research was underway on the etiology of severe protein-energy malnutrition and on tests related to these conditions. There was still much emphasis on protein deficiency and the need for consumption of more protein by children at risk.

A study in Tanzania seemed to show that additional protein in the diet of children significantly improved hemoglobin levels (Latham 1960). Another study showed that “protein rich foods” provided as a mid-day school snack led to significantly greater weight gain and greater improvement in hemoglobin levels than in control children (Latham and Robson 1965). Of course the snack added calories and other nutrients to the children’s diets.

Hair changes

Because hair changes are among the distinguishing clinical features of kwashiorkor, during the 1950s and 1960s interest was given to hair analysis as a diagnostic technique. This included inconclusive work on sulphur containing amino acids in hair. Many clinical descriptions, as well as personal experience with hospitalized children in Tanzania, revealed not only hair color changes in children with kwashiorkor, but also that the hair seemed weaker and of a different texture than normal African hair. A search of the literature showed no studies had been done comparing the strengths and weaknesses of hair. While at Harvard University, and using the modern Instron machine in the Fiber Division at MIT, Michael conducted a study on the tensile strength of hair from severely malnourished and healthy Colombian children under 5 years of age. Fifteen were well-nourished and 14 malnourished (12 with kwashiorkor and two with nutritional marasmus). Their hair was collected by the author in Medellin. The mean fracture point of hair was 82.3 g in well-nourished children and 35.5 g in those malnourished, a highly significant difference. The mean “yield points” were also significantly different (Latham and Velez 1966).

Some years later Allan Johnson, in partial fulfillment of his Cornell Master’s degree, undertook a study evaluating the changes in hair root morphology in the assessment of protein-energy malnutrition (Johnson, Latham and Roe 1975). He studied 55 Jamaican children under 5 years of age in the University Hospital, some healthy and well-nourished and others with nutritional marasmus or kwashiorkor. Five hair characteristics were measured: percentage of anagen, percentage of telogen, percentage of atrophy, diameter of anagen bulbs, and shaft diameter. Significant differences were found in shaft diameter, percentage of anagen, and percentage of telogen, only between well-nourished and severely malnourished children. It was concluded that because the tests are time consuming and can only be used for differentiating well-nourished from severely malnourished children, this method could not be recommended for wider use (Johnson, Latham and Roe 1975).

Milk in the treatment of kwashiorkor

A study was conducted in Ethiopia to investigate the possible effect of lactose in the dietary treatment of kwashiorkor. This was done because cow's milk is the basis for most diets used in the treatment of kwashiorkor and lactose can produce diarrhea in those with low lactase levels. Deborah Rothman, for her Cornell Master's thesis, conducted this research in the Ethio-Swedish Pediatric Clinic in Addis Ababa in collaboration with its Director, Dr. Demissie Habte, and Dr. Michael Latham (Rothman, Habte and Latham 1980). Twelve children with kwashiorkor, aged 10-50 months, were studied in detail as in-patients in the clinic. This was a cross-over design with six children receiving a lactose free diet on days 1-3 and 9-11, but cow's milk on days 5-7. Another matched six children received cow's milk on days 1-3 and 9-11, and a lactose free diet on days 5-7. Between those periods was an "adjustment day". Among the important data collected for comparison between lactose containing *versus* lactose free days were stool weight, concentrations of sugar in the stool, stool PH and transit times. Almost all 12 children showed a rapid recovery as judged by parameters such as appetite return and mood improvement. Although there were some differences (not significant) in some parameters, there was no clinical evidence to suggest adverse effects resulting from the cow's milk based diet. It was concluded that milk is not contraindicated in the treatment of kwashiorkor, certainly in Ethiopia.

Impact of malnutrition on intellectual development

In the 1960s and 1970s many studies were done on the role of malnutrition on intellectual development of children reflecting the huge interest in that area. Important early work in Mexico (Cravioto, de Licardie and Birch 1966) showed that, following recovery from severe malnutrition, children scored lower than normal children on tests of intellectual development.

In 1968, fieldwork began on a major study on malnutrition and intellectual development of children in Bogotá, Colombia. This was a collaborative study involving the Colombian Institute of Family Welfare, Harvard University, and Cornell University (Latham and Cobos 1971). It was to be conducted in three phases: the first was a large cross-sectional study; then a 3 year study using sibling pairs, some malnourished and some well-nourished, supplied with dietary supplements; and finally a 5 year definitive longitudinal study. The advantage of a sibling study is that it, in part, controls both for genetic and environmental factors, which have precluded studies from drawing definitive conclusions on the actual impact of malnutrition on mental development. The cross sectional study showed that previously malnourished Colombian children had significantly lower scores than did well-nourished children on the Griffiths scales for locomotor, personal-social, hearing and speech, eye and hand, and performance. Results also showed an impact of socio-economic status on their scores. Social deprivation and malnutrition often co-exist, and this limits firm conclusions based on cross-sectional studies of malnutrition and intellectual development.

There was an assumption that this intellectual retardation in malnutrition was due to poor brain development, perhaps lower head circumference and brain size, and reduced amounts of brain DNA, RNA and protein. In the research in Bogotá a new hypothesis was proposed and in part tested. This was that poorer performance by previously malnourished children could be due to the fact that calorie or energy deficiencies had restricted activities

and learning opportunities, and that this is what influenced test scores, rather than brain pathology (Latham and Cobos 1971).

Peter Heywood as part of his Cornell Master's degree tested this hypothesis. This was done by measuring physical activity in malnourished and well-nourished children using the SAMI (Socially Acceptable Monitoring Instrument) heart rate counter (Heywood and Latham 1971). It is well known that a chronic energy deficit will lead to a reduction of activity in adults. This physiological response to a calorie deficient diet is a protective mechanism to conserve energy. The young child, faced with a chronic deficit in energy intake, could also be expected to respond by conserving his or her energy for basic metabolism, growth and essential activities, rather than for play with peers, verbalizing, and manipulating objects. The child's passivity may then reduce his interaction with his mother and with others.

The SAMI proved feasible in terms of measuring activity in children. During a period of approximately 2 months, it was used on 18 children, ten of whom had protein-calorie malnutrition and eight of whom were well-nourished controls. The malnourished children showed retarded physical growth (all but one were below 75 % of expected weight-for-age). They were not acutely ill at the time of the testing and none had edema.

The preliminary results indicated differences between malnourished children and sex and age-matched controls. The mean number of heartbeats per minute of the malnourished subjects was considerably lower than that of the well-nourished controls.

A subgroup of four malnourished children was chosen for the longitudinal study. All were on a diet which was designed to improve their growth and nutritional status. The SAMI was used at the beginning of the study and again approximately 3 and 6 weeks later. Heart rates during a 2-to-4-hour period of activity at three stages of recuperation were obtained. In this subgroup, each subject acted as his own control and heart rate served as an index of activity. The results of this part of the study are less clear-cut than in the comparison of well-nourished with malnourished children. However, there is a suggestion that activity increased as recuperation progressed. Clearly, the number of children was very small, the period of time allowed for recuperation was short, and several intervening factors need to be considered in this type of study.

The hypothesis that energy deficits in early childhood leading to lower levels of activity and fewer learning opportunities may result in poorer scores on intellectual tests remains unproven, but is still valid.

In a definitive invited review on malnutrition in children and its relation to psychological development and behavior for the influential journal *Physiological Reviews* (Latham 1974), Michael agreed with a 1973 position paper of the *Food and Nutrition Board* of the *National Academy of Sciences*, and reiterated:

At present, it is impossible to say whether malnutrition, *per se*, contributes more or less to the depressed cognitive development of previously malnourished children than do unfortunate social and environmental conditions. No investigation has completely addressed the question of the relative importance of malnutrition

versus social environment factors in cognitive development; the findings have consistently been that both are significant.

Hormone levels in severe malnutrition

In the 1970s there was much interest in finding biochemical differences, including in hormone levels, among children with different forms of severe protein-energy malnutrition. For her Cornell Ph.D. dissertation, Ifeyironwa Smith studied malnourished children in Nigeria. In those with clinical evidence of protein-energy malnutrition and in age matched controls between 8 and 34 months of age, she evaluated the relationships among serum albumin and plasma growth hormone, insulin somatomedins, and free and total cortisol.

The children were recruited from the General and Teaching Hospital in Enugu. The results showed that insulin and somatomedin levels were reduced, while growth hormone and free and total cortisol levels were elevated, in malnourished compared with well-nourished Nigerian children. Though the mean somatomedin activity levels were significantly lower ($p < 0.005$) in malnourished children, the mean was not different between those with kwashiorkor compared with those with nutritional marasmus. From this research it was suggested that the high plasma – free cortisol and reduced insulin levels were partially responsible for the depressed stimulation action of somatomedin or protein synthesis and growth (Smith, Latham, Azubuike, Butler *et al.* 1981).

Gut permeability in severe malnutrition

Much research on severe malnutrition in animals and humans has suggested that there are important pathological changes in the intestines, including an altered mucosal barrier, allowing increased intestinal permeability to enteric antigens. Deborah Rothman, for her Cornell Ph.D., conducted studies on rats in the Massachusetts General Hospital laboratories of the Harvard University Department of Pediatrics in Boston.

It had previously been demonstrated that increased quantities of bovine serum albumin (BSA) and its breakdown products of large molecular weight were present in the serum of malnourished rats after its instillation into the duodenum. However, it had not been established whether this increased circulating BSA was related to enhanced intestinal permeability due to changes in the mucosal barrier or to the other factors associated with malnutrition, such as impaired intravenous clearance of the protein after it has crossed the mucosal barrier. To determine if altered clearance of intravascular antigens occurred, 125 I-BSA was injected intravenously into four malnourished and four control rats, and total serum radioactivity measured both before and after precipitation with TCA, at intervals of 4 hours. Uptake and degradation by the liver of 125 I-BSA were also measured. Both total and TCA precipitable serum radioactivity did not differ significantly between groups at any of the times tested. Furthermore, the rate of 125 I-BSA uptake by the liver was nearly identical for both groups, although the malnourished degraded it to a slightly lesser extent than the controls. These findings appear to eliminate the possibility that delayed intravascular clearance accounts for increased serum levels of antigen in malnourished animals, and supports the hypothesis of increased intestinal permeability to macromolecules in malnutrition (Rothman, Latham and Walker 1982).

Determinants of malnutrition

In 1975, in partial fulfillment of his Cornell Master's degree, and in collaboration with the Caribbean Food and Nutrition Institute (CFNI), Ted Greiner conducted research to look at factors associated with malnutrition on the island nation of St. Vincent. The study included 200 children between 12-24 months of age from two towns. They were from poor families and mothers were interviewed in their homes. Seven percent had running water, 2 % had flush toilets and only 17 % of mothers were legally married to the father of the study child. Using multiple regression analysis, the variable which had the greatest impact on nutritional status was economic level of living. Next in importance came length of breastfeeding, followed by attendance at postnatal clinics and (with a negative association) number of siblings. Mean age of *sevrage* (conclusion of breastfeeding) was 7 to 8 months.

It was concluded that, while the major prerequisite for improving nutritional status was improvement of economic well being, the role of breastfeeding and late *sevrage* may also be important. The only other variables which had a sizeable impact on nutritional status were the number of living siblings and the number of postnatal clinic visits. This suggests that measures to lengthen child spacing and the development of appropriate health care may also contribute to improving nutritional status (Greiner and Latham 1981).

As part of the research for her Cornell Ph.D. dissertation, Sonya Rabeneck conducted a detailed study of the determinants of protein-energy malnutrition among pre-school children in two villages in Machakos District in Kenya. The cross-sectional study was designed to investigate the determinants of preschool malnutrition, specifically regarding self-sufficiency in staple food production and cash-cropping (coffee growing). Carried out in two adjacent villages, the study involved all households with preschool children (n = 202). Anthropometric measurements were performed on all children while agricultural and marketing data were collected by interview with their mothers (n = 243). Households were divided into four groups: group I no coffee, no staples; group II coffee, no staples; group III coffee and staples; group IV staples only. Groups did not differ by selected socio-demographic variables. Among households producing staple foods, group III children (n = 246) had higher percent height-for-age ($92.0 + 4.4$ vs. $90.3 + 4.6$, $p < 0.025$) than group II children (n = 68). Among households producing no staples, group I (n = 14) had greater *per capita* staple kilocalories ($p < 0.025$), greater kilocalories from non-agricultural foods ($p < 0.05$) and greater total available kilocalories ($p < 0.025$), than group II households (n = 20). The results suggest that coffee growing may be an advantage among households already producing staple foods, but may be a disadvantage among households who do not (Rabeneck and Latham 1982).

Positive and negative deviance in nutrition

Marian Zeitlin deserves credit for initiating and encouraging the study of "positive deviants" in communities where malnutrition was prevalent, mainly as a means to gain insights into the causes and, perhaps feasible, control measures. The term positive deviance was used to identify children who "grow and develop well in impoverished environments where most children are victims of malnutrition and chronic illness" (Zeitlin, Ghassemi and Mansour 1990).

In different forms, using different terminology, a similar concept has been used by others at different times. Margaret Evans, for her Cornell Master's degree, used a design devised by Michael to study "differences in the diets of well-nourished and malnourished children in a relatively homogeneous setting" in Jamaica. This was to "demonstrate the relation between nutritional status, dietary variables, and several socioeconomic and health variables, in affecting nutritional status" (Evans 1974). Compared with children of poorer nutritional status, those with better nutritional status (now called "positive deviants") were found to have had a longer duration of breastfeeding, earlier introduction of supplementary foods, a larger number of different foods consumed at 12 months of age, and less anorexia (poor appetite). It was suggested that these findings could be used for corrective measures.

Without using the "positive deviance" concept, Preethi Fonseka, for her Cornell Master's degree, investigated selected variables that influenced nutritional status of children in rural areas of Sri Lanka (Fonseka 1983). Factors associated with better nutritional status included being brought up in a village rather than on a tea estate, low birth order, mother's registration with a midwife prior to delivering, and higher ratio of cultivation of food crops rather than cash crops.

In 1988, Thabisile Hlatshwayo, for her Cornell Ph.D., investigated positive and negative deviance in Lesotho (Hlatshwayo 1988). Unlike in much of Asia, being female rather than male, was significantly associated with being positively deviant. Other variables associated with positive deviance were longer birth intervals, smaller number of household members, mother's literacy, and better breastfeeding practices.

In 1991, for her Cornell Ph.D., Aicha Lemtouni investigated the determinants of positive deviance in Morocco, this time in part of a poor urban setting in Rabat. A strong finding was that negative deviance was significantly associated with poor appetite or anorexia. Positive deviance was associated with smaller family size, less frequent feeding of solids after 6 months of age and a smaller variety of foods offered, more hand washing by mothers, and mothers spending more time on child care.

As mentioned earlier, in 1988 Meera Shekar, for her Cornell Ph.D. degree, investigated the monitoring and information system in the Tamil Nadu Integrated Nutrition Project (TINP), a major health and nutrition intervention covering nearly 1 million children in rural south India (Shekar, Habicht and Latham 1991). She used a nested case-control study design in which positive deviants and negative deviants were contrasted with what were termed "median growers". A sample consisting of 100 each of positive and negative deviants and 120 median growers was selected after analyzing the 12-month growth patterns (weight-for-age) of 2954 children enrolled in TINP. So as to address the question of what more needs to be done, the determinants of poor growth that had been left unaddressed by 6 years of TINP exposure are delineated here as well as the rationale for differential targeting of services to negative deviants and to median growers, and the implications for program evaluation. The next generation of projects targeted at the most needy (negative deviants) should address the issues of gender discrimination in childcare, of breastfeeding, of diarrhoeal disease, and of maternal empowerment. Such interventions will, however, not improve the growth of median growers in the direction of positive deviance. Instead, programs targeted at the median growers need to support the hygienic use of non-breastmilk

supplements. Improving family wealth will also improve the nutritional status of the median growers, but less so than for the negative deviants (Shekar, Habicht and Latham 1991).

These studies added the term “median growth” to the common studies of “positive deviance” with the assumed converse of “negative deviance”. Analyses were thus conducted to help answer the question “is positive deviance in growth simply the converse of negative deviance?” The analyses support the hypothesis that, for many variables, positive and negative deviance in growth exist as distinct conditions promoted by different mechanisms, and they are not the converse of each other. The data indicate that, as compared to median growers, positive deviant children come from wealthier families that consume more prestige foods, and their mothers work fewer hours. These factors do not, however, predispose to negative deviance, which is characterized by female sex, lower maternal wealth, and lower consumption of protein-rich foods such as pulses. These findings have clear implications for program targeting, design, and evaluation (Shekar, Habicht and Latham 1991).

Anorexia or reduced appetite as a cause of malnutrition, or a result of nutrient deficiencies and infection

Anorexia is a medical term for lack of appetite, a common symptom. The literature mentions anorexia as being a feature, or symptom, of many diseases. However, there is rather little research on this and practically no well-designed studies to show that appetite can be positively influenced by a particular intervention. Anorexia is an important “symptom” for nutritionists, because assuring food security, which is a nutrition goal, may not prevent malnutrition if the desire of people to consume enough food is reduced by anorexia.

Michael and his colleagues have conducted research to investigate the possible role of anorexia as a factor resulting in the poor physical growth of children related first to parasitic infections and second to iron deficiency anemia. Despite the fact that many physicians and almost all medical textbooks categorically state that numerous specific diseases cause a poor appetite, there exist no accepted test of appetite.

Michael first designed and used a new appetite test in a study of the impact of treating the parasitic infection schistosomiasis on appetite in Kenya (Latham, Stephenson, Kurz and Kinoti 1990). Appetite was assessed by measuring children’s intake of a maize based porridge (locally called *uji*) offered *ad lib* at one sitting on three different days under controlled conditions. *Uji* is a popular local food made by cooking maize meal in water with sugar and milk. The tests were conducted late in the morning, after a field worker had done a recall of food eaten the day prior to the test and asking about the child’s perception of his or her appetite. A 1 liter open-top plastic jug of *uji*, together with a mug and spoon, were provided to each child sitting at a table. A semi-liquid, *uji*, can be easily poured into the mug and either drunk or eaten with a spoon. Each child was told to consume as much as he or she desired and if the 1 liter jug was emptied it was refilled. The remaining volume was then determined to measure the amount consumed by each child. This test was also used in research to determine whether treatment of common intestinal helminthic infections improved appetite. And it did, which may explain why growth improves with deworming.

A double blind study was also undertaken to determine if the appetite of young school children receiving iron improved more than for those receiving a placebo. At the baseline,

there were no significant differences between groups in mean age, gender distribution, presence of splenomegaly and hepatomegaly, anthropometric measures, hemoglobin, serum ferritin, or hookworm egg counts. Before the intervention, at Exam 1, there was no significant difference in *uji* consumption between the iron group and the placebo group. They respectively consumed a mean of 406 and 408 Kcal from *uji*. After 16 weeks of intervention, the mean energy intake at the time of the appetite test was 557 Kcal in the iron group and 448 Kcal in the control group, a highly significant difference ($p < 0.001$) (Lawless, Latham, Stephenson, Kinoti *et al.* 1994).

Children at each examination were asked to rate their own appetite on a scale from 1 to 5, where 1 indicates “very poor” and 5 “very good”. At Exam 1, there was no difference in appetite rating between the two groups. At Exam 2, the appetite of those taking iron had improved, whereas it had not changed in the control group. The iron supplemented children also showed a significantly greater rise in hemoglobin (+3.2 vs -2.4 g/L) and serum ferritin (+16.5 vs +0.3 ng/ml), compared with the control group, as well as greater increases in most anthropometric measures. For example, weight increased by a mean of 1.58 kg in the iron group and 0.69 kg in the control group, a significant difference ($p < 0.01$).

The results of this study confirm our earlier findings, and those of others in Indonesia and elsewhere, that providing iron supplements to children improves their growth in areas where iron deficiency and protein-energy malnutrition are prevalent. The study also shows for the first time that iron supplementation improved food intake and seemed to reduce anorexia, or poor appetite. This suggests that one explanation for improved physical growth by provision of iron is that it increases the desire to eat, and presumably where adequate food is available, increases food intake. The increased intake of energy and other nutrients in food leads to improved growth.

The data from the studies summarized here suggest that the depressed growth associated with both, iron deficiency and certain parasitic infections, may, in part, be due to depressed appetite from these conditions. Depressed appetite may lead to decreased intake of food, which in turn slows the rate of growth of children or causes weight loss in adults, and also may result in lowered physical fitness, activity, work output, and cognitive performance. Lowered food intake also reduces the intake of micronutrients such as iron, thus worsening the anemia and establishing a vicious cycle.

Anorexia is often stated to be a feature of infections and of micronutrient deficiencies, but the literature is rather sparse and suggests that this oft repeated view is most often based on subjective observations not rigorous measurements. Appetite and food intake in relation to these conditions have seldom been objectively assessed in well-designed studies.

Development strategies need to aim at food security for poor families, to ensure an adequate energy and nutrient intake, both for their needs and their wants. When insufficient food is available, poor persons often maintain energy balance by reducing activities. But when sufficient food is available, then people need to consume enough to satisfy their energy and nutrient needs and wants. If poor appetite restricts the amount that they eat, this may limit children’s growth, adults’ work output and peoples’ well being. So, if anorexia or poor appetite, due to iron deficiency or parasitic infections, limit food intake, then people may not

satisfy their needs even if sufficient food is available to the family. This is more likely to happen when staple dishes are bulky and have low energy density, and where meals are infrequent.

Breastfeeding and water – rational home management of diarrhea

Stina Almroth, while a graduate student at Cornell and Michael's advisee, did pioneering research first in Jamaica (Almroth 1978; Almroth and Latham 1982) and later in India, largely proving that exclusively breastfed infants in the first months of life do not require additional water, even in a very hot environment. This was an important finding. Its acceptance meant that the UNICEF/WHO meeting on breastfeeding held in Florence in 1990, and its Innocenti Declaration, stated that exclusive breastfeeding means that an infant receives only breastmilk and that no other drink or food be given. Exclusive breastfeeding for the first 6 months of life has since then been increasingly promoted worldwide, although not very widely practiced.

Accordingly, research was undertaken in Lesotho, a small landlocked country with an ethnically homogeneous population of only around 2 million people, to study the reasons for the unnecessary water supplementation of babies (Almroth, Latham and Mohale 2000). One aim was to collect policy and program relevant data on exclusive breastfeeding in the country. It was done in 1991 and 1992, at a time when global recommendations for exclusive breastfeeding were relatively new.

During both phases of the field research, qualitative information was obtained through focus groups and individual interviews with mothers, grandmothers, and nurses. This was complemented during the second phase with quantitative data collected through a clinic-based survey of mothers. The qualitative and the quantitative findings consistently converged, illustrating a culture of infant feeding in which breastfeeding was central, but exclusive breastfeeding was an unknown concept and not practiced. Grandmothers seemed to be more in tune with the ideal of exclusive breastfeeding as they had given their young infants thin gruel only occasionally. Contemporary mothers, in contrast, were regularly giving their young infants water. Mothers and grandmothers frequently cited nurses as the source of advice for giving water. Grandmothers were adamant in pointing out that they had never given water to their own young infants and asserted that they avoided giving it to their grandchildren as they considered it unnecessary and harmful. According to them, water supplementation was a new practice that had been introduced through the clinics. It was concluded that efforts to discourage water supplementation in the first 6 months of life in this setting needed to be aimed not only at mothers, but importantly also at health workers. It was stated that this may well apply in other settings.

Based on careful reviews of the very extensive literature on oral rehydration therapy (ORT) and findings in Lesotho, the sometimes irrational use of oral rehydration salts (ORS) was examined. The discovery that glucose, through a sodium-coupled transport mechanism in the small intestine, enhances fluid absorption, even during diarrhea, had been hailed. In an Editorial, the *Lancet* had proclaimed this as "potentially the most important medical advance this century".

So it was pleasing that the *Lancet* should, 7 years later, publish our paper on the rational home management of diarrhea, suggesting that ORS was not uncommonly irrationally used and could then be harmful (Almroth and Latham 1995). The paper showed that claims, beyond evidence based results, were being made for the benefit of ORS. Thus WHO had a program “to make ORS as widely available as possible” for treatment and prevention of dehydration, and in 1983, the first International Conference on Oral Rehydration Therapy stated that “everyone recognized that oral rehydration therapy is an effective, simple, and inexpensive technology that can become sustainable within most communities”. We suggested that, without adequate research, “a solution that had been developed for treatment of dehydration in hospital was now presumed to be equally suitable for prevention of dehydration at home”. At this early stage few people in research or medical practice had boldly suggested that giving almost any food, with sufficient water could prevent dehydration.

Reluctance to consider food for the prevention or treatment of dehydration was partly due to the fact that in conventional clinical management of diarrhea, food was excluded. This was slowly changing, but feeding was mainly being encouraged for “nutritional purposes and was thought to interfere with, rather than enhance, rehydration. It was recommended that food, including breastmilk, be withheld during the initial rehydration phase” (Almroth and Latham 1995). This too was based on untested theoretical concepts, later proved incorrect. Another assumption often made was that oral rehydration is easy to use, but studies carried out in six countries showed that 23-70 % of mothers had prepared sugar-salt solutions with “dangerously high sodium concentrations”. In 1995, Almroth and Latham wrote (Almroth and Latham 1995):

Oral rehydration therapy for hospital use was developed in response to recognized programs and identified needs. Home-use of oral rehydration therapy was proposed, not on the basis of assessments of problems at home and the need for interventions, but largely on the basis of the assumption that what applied in hospital could be extended to the home.

However, management of diarrhea differs between hospital and home. Diarrhea seen at the hospital tends to be more severe than in the home. Thus, for the doctors in hospital, it is reasonable to expect that nearly every case will require treatment; for the mother, or other caregiver at home, it makes most sense to take simple measures with materials at hand before turning to specialized treatment.

It is an advantage to use a single formula in hospital settings where procedures are standardized, but not at home where there is great variation from one household to another. Yet recommendations for home treatment were made to resemble as closely as possible those for the hospital.

We consider such a restrictive approach to have been neither necessary nor helpful. The ORS formula is not a physiological ideal – although at times it has been considered to be. To the extent that fluid composition matters, it surely matters less at home, where the main objective is to treat diarrhea and prevent, rather than treat, dehydration. The composition of foods and fluids prepared at home may be variable, but hardly to an extent that would be dangerous. Limitation of the number of

recommended home fluids and foods is unnecessary, and may be harmful, since caregivers may infer that fluids that are not recommended should not be given.

Perhaps because doctors managed diarrhea by restricting food intake, it was assumed that mothers, too, were withholding food. However, assessments in Bangladesh, Saudi Arabia, India, Peru, Mexico, Nigeria, Kenya, Swaziland, and our own in Lesotho, indicate that, in these countries, this was an erroneous assumption (Almroth, Latham and Mohale 2000). Mothers commonly expressed concern about their children's poor appetite during diarrhea and made special efforts to feed them. We found in Lesotho, that mothers were convinced that feeding, including breastfeeding, should continue during diarrhea in order to keep the child strong. This conviction was so firmly held that virtually all the mothers and grandmothers we interviewed said they had refused to follow health workers' advice to stop feeding. We interpret these findings as evidence of skillful practices for managing diarrhea, instead of dismissing cereal-based "grandmother solutions" because "if they had been effectively made and used, there would have been few deaths from diarrhea". We prefer to ask how many deaths have been averted because cereal-based solutions were effectively made and used?

If the concepts of protection, support, and promotion were applied to the management of diarrhea at home, perhaps the first priority should be to protect existing feeding practices, which will be beneficial from the point of view of hydration as well as nutrition. By not acknowledging and respecting existing practices in the community, we risk destroying them and even causing harm. In Lesotho, we found that a side effect of the promotion of ORS and sugar-salt solution was that dilute "water with sugar and salt" solution was given routinely, even when infants did not have diarrhea.

As failures of ORS at home have become apparent, more rational guidelines for the use of ORS have emerged. However, a program for home management of diarrhea will remain fundamentally irrational if built on the premise that ORS is the ideal therapy that should be used if at all possible. ORS is not needed for most cases of diarrhea at home. Home-based fluids and foods may be at least as effective and are simpler and cheaper. Rational use of ORS at home implies that it should be limited (Almroth and Latham 1995).

An unanswered question is whether the use of ORS and similar solutions for infants that do not have diarrhea may in fact be reducing the intake of breastmilk.

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Chapter 3 - Parasites and nutrition

Introduction

We live in a wormy world. That at this moment some 2 billion people (a third of the world's population) carry a burden of worms, unwanted guests in their intestinal tracts, should be unacceptable (Latham 2008). The impact of helminthic parasites on nutrition has been the focus of many studies by the Cornell group over the last 3 decades or more. The central figure in this research has been Lani Stephenson who completed her Ph.D. on this topic in 1978. Her book, *The Impact of Helminth Infections on Human Nutrition* published by Taylor and Francis, remains an important reference on the subject (Stephenson 1987). In much of the research done in East Africa, Michael Latham, plus several colleagues and graduate students at Cornell, contributed importantly.

This collaborative work led to over 80 publications where the three common intestinal helminthic infections, and also Schistosomiasis, were shown to have an important impact on child growth, anemia, physical fitness, physical activity and labor productivity, and on appetite. Along with research by others, this led to much more attention than previously to deworming and treatment and, in some countries - and in some programs - to major regular provision of anthelmintics to rid people of worms. But the hope that a major effort be undertaken to deworm almost all the world's children has not been accomplished even though James Grant, the then dynamic Executive Director of UNICEF wrote in 1982 (Grant 1982):

Today, an invisible malnutrition touches the lives of approximately one quarter of the developing world's young children. It quietly steals away their energy; it gently restrains their growth; it gradually lowers their resistance. And in both cause and consequence, it is inextricably interlocked with the illnesses and infections which both sharpen, and are sharpened by, malnutrition itself. Perhaps as many as half of all cases of severe child malnutrition, for example, are precipitated not primarily by the lack of food but by intestinal parasites, fever and infection – especially diarrhoeal infection – which depresses the appetite, burns the energy, and drains away the body weight of the child (Grant 1982).

In 1983 Michael thought that he had convinced, and persuaded, Jim Grant to take this on as a major UNICEF activity. Disappointingly, this did not happen and UNICEF concentrated on GOBI (for growth monitoring, oral rehydration, breastfeeding and immunization)(Grant 1985).

The three intestinal helminths which were addressed in the Cornell research are roundworms infecting about 1.4 billion; hookworms infecting 1.3 billion; and *Trichuris* infecting 1.05 billion people. With successful control in northern countries these infections have become mainly poor people's diseases. The majority of persons infected do not die directly from these infections, but the quality of their lives is compromised. These infections contribute importantly to high rates of malnutrition and poor growth of children, and hookworm infections are an important cause of anemia. They lead to anorexia or poor appetite, they may limit worker productivity and school performance, they may adversely

impact pregnancy, and they do contribute to mortality. It should be recognized that diseases like these that have low case fatality rates in fact kill a lot of people because so many people have the disease. Farmers in Upstate New York (and in most parts of the industrialized world) routinely deworm their piglets, knowing that they grow better (produce more pork) and pet owners regularly deworm their cats and dogs, yet we leave hundreds of millions of children harboring these parasites. Surely we have a global obligation to support deworming, and children have a right to be kept free of these parasites.

Using disability-adjusted life years (DALYs) lost per annum, the World Bank estimated 22.1 million life years lost for hookworm, 10.5 million for roundworms, and 6.4 million for *Trichuris*. The combined loss for these three worm infections is a whopping 39.0 million life years, while that for malaria is 35.7 life years, for vitamin A deficiency 11.8 million, and for diabetes 8.0 million (Stephenson, Latham and Ottesen 2000).

In addition to the research on these intestinal helminthic parasites, the Cornell group conducted many important studies on Schistosomiasis, mainly *Schistosoma hematobium*. Schistosomes are a type of blood fluke and male and female adult *S. hematobium* flukes live mostly in blood vessels around the bladder and urinary tract. The presenting symptom is often blood in the urine (hematuria).

Between 1976 and 1990 Michael spent three 12 month sabbatical leaves in Kenya with Lani Stephenson, involved in research on parasitic infections and concluding other studies, and work, including teaching. The first sabbatical leave was based in Nairobi in 1975-1976. It included appointments at the University of Nairobi and the Kenya Medical Research Center, but much time was spent in the field in Machokos District, as well as in Nyeri, West Pokot and Kwale. The other two sabbatical leaves were based mainly in Kwale District, some 40 miles south of the port city of Mombasa. Between these sabbatical leaves, both Lani and Michael made frequent long visits to Kenya to complete several of these field studies. Both had appointments over many years at the Kenya Medical Research Institute (KEMRI), collaborating with physicians and scientists there.

In most of the studies, Lani did much of the data collection and laboratory determinations herself while Michael undertook the clinical examinations and the fitness tests, as well as much of the anthropometry. Over the years at different times some Cornell graduate students assisted enormously with different parts of different studies. These included Mark Brooks, Terry Elliott, June Wolgemuth, Jeanne Lawless, Kathy Kurz, Liz Adams, and from Cambridge, Andrew Hall. Other faculty and professionals involved were Dr. David Crompton from Cambridge who spent much time in the field in the Machokos study; Dr. Malden Nesheim (CU); and Susan Arnold (Cambridge). The very important collaborators in Kenya were Dr. Stephen Kinoti (over a period of 15 years); Dr. Martin Oduori; Dr. Ad Jansen; and Ms. Ann Pertet.

Roundworm (*Ascaris*) infection

Ascaris lumbricoides infections occur almost worldwide and are cosmopolitan in distribution, including in temperate environments. But high prevalence rates occur where there is poverty, poor sanitation and water supplies, high population density, and favorable climatic conditions. These are large worms (15 to 35 cm in length), they live in the small

intestine, and the female worm produces thousands of eggs per day which pass out in the feces. Humans contract ascariasis by ingesting embryonated eggs. These hatch in the small intestine, the larvae migrate to the liver and then the lungs, develop further, pass up the trachea, and then reach the stomach. The extent to which this migration through the lungs contributes to respiratory symptoms and allergies is not exactly known – but is considerable. In the intestines, large numbers of roundworms can get entangled and cause intestinal obstruction. Without early successful surgical interventions, these obstructions have been reported to be a not uncommon cause of child deaths in countries such as Brazil.

Before investigating the impact of worm infections in African children, Lani Stephenson, as the first part of her Ph.D. dissertation, conducted research on *Ascaris suum* in pigs and their impact on nutrition (Stephenson 1978). Dr. Malden Nesheim, then Director of DNS, was chairperson and advisor for her dissertation. In a series of experiments, investigations were done on littermate piglets, some artificially infected with *Ascaris* and some not infected. *Ascaris* infected baby pigs showed significantly lower weight gain, and reduced food intake, than did uninfected matched pigs (Stephenson 1987). Pathological conditions were also observed, mainly hypertrophy in the small intestine of infected piglets.

Clinical studies on *Ascaris* infection in children

In 1975-1976, a study was conducted to measure the effects of *Ascaris lumbricoides* infection on growth, nutritional status, and health of pre-school children in a rural area of Machokos District in Kenya (Stephenson, Crompton, Latham, Schulpen *et al.* 1980). A total of 186 children aged 12 to 72 months were examined three times at 3.5 month intervals. Anthropometric, clinical, and stool examinations were performed. All children received levamisole treatment at the second examination. In the 3.5 months after deworming, previously infected children had a significantly higher weight gain and percent expected weight gain, than did uninfected levamisole treated children. Triceps and subscapular skinfold thicknesses also increased significantly after deworming in previously infected children, compared with uninfected children. It was concluded that even relatively light *Ascaris* infections may adversely influence nutritional status, and that deworming may enhance growth.

This study was followed by a 4 year project to evaluate the control of *Ascaris* infection in the same two Kenya villages. This was partly an action project, since parents and school teachers requested continuing deworming as they felt this had greatly benefited children. Some 1550 children were enrolled, around 40 % of pre-school age, and 60 % of school-age. All received an appropriate dose of levamisole every 4 months for a total of 12 doses over 4 years. The project was extremely well accepted and supported by teachers, parents, and the children themselves, illustrating the popularity, and feasibility, of community deworming of children. There was a large 82 % decrease in *Ascaris* infection following the first dose of levamisole, from 28 to 5 % having positive stools. The cost of the levamisole dose per child was 5 US cents, and the delivery system consisted of two female fieldworkers hired from the community.

Parallel with this, another study estimated the costs, prevalence and control of *Ascaris* infection in Kenya (Stephenson, Latham and Oduori 1980). Clearly in Kenya, as in almost any tropical or sub-tropical non-industrialized country where the prevalence of *Ascaris* and

other intestinal worm infections are very high, the health impact is large, and yet control is possible at relatively low cost (Stephenson, Latham and Ottesen 2000). Examining data province by province, it was estimated that 25 % of the Kenyan population were infected with *Ascaris* for a total of over 4 million persons (Stephenson, Latham and Oduori 1980). Based on Ministry of Health statistics, only 2.6 % had received treatment in 1976. The estimated cost per year of the medicine to treat 100 % of cases was less than US \$200,000.

Multiple helminthic infections (Hookworm, *Ascaris* and *Trichuris*) - impact on children's nutrition

Concurrent with the research on *Ascaris* in Machokos District, and following it, a number of studies were done elsewhere in Kenya to help determine the impact of multiple helminthic infections on nutrition in children. Much of this involved long field studies in Kwale District where there were very high prevalences of infection with hookworm, *Ascaris* and *Trichuris*. Separate studies were done on schistosomiasis in children, and also on malaria (Stephenson, Latham, Kurz, Kinoti *et al.* 1989).

An early study demonstrated that treatment with a single dose of albendazole improved the growth of school children infected with hookworm (87 %), *Ascaris lumbricoides* (49 %), and *Trichuris trichiura* (97 %). Children were randomly allocated to receive either a single dose of 400 mg of albendazole (n = 78), or a placebo (n = 72), and re-examined 6 months later when all children in both groups received 400 mg of albendazole. Over a period of 6 months, the treated group gained significantly ($p < 0.0002$) more than the placebo group in weight (1.3 kg); percent weight-for-age (4.5 % age points), percent arm circumference (2.9 %), and triceps and subscapular skinfold thicknesses-for-age. Only height-for-age did not show a significant increase. Based on fecal egg counts, decreases in intensity of all three infections were significant predictors of growth improvement. It was concluded that, despite continued exposure to reinfection, treatment with albendazole can permit improved growth in areas where intestinal helminthic infections and poor growth of children are prevalent.

A further study in Kenya again showed improvements in the anthropometric indices in school children treated for intestinal helminthic infections, compared with those receiving placebos. This study also examined whether, in this environment, there were differences in growth between children receiving once or twice yearly treatment with albendazole 600 mg (Stephenson, Latham, Adams, Kinoti *et al.* 1993a). Following, are excerpts from the abstract:

Children were examined and allocated at random, within sex by descending hookworm egg count, to one of three groups: placebo (n = 93), one dose (1x, n = 96) or two doses (2x, n = 95). Each child was treated and then re-examined and treated 3.6 and 8.2 mo later (Exams 2 and 3). The 1x and 2x groups gained significantly more by Exam 3 than the placebo group in weight (1.1 and 0.9 kg more, respectively), percent weight-for-age (3.3 and 2.7 percentage points more), percent weight-for-height (3.1 and 2.9 percentage points more), percent arm circumference-for-age (2.3 and 2.0 percentage points more), and triceps and subscapular skinfolds, but they did not differ significantly from each other. The placebo group showed significant decreases between exams ($p < 0.0002$) in percent weight-for-age and

percent arm circumference-for-age, and no change in percent weight-for-height, whereas the 1x and 2x groups exhibited significant increases ($p < 0.005$). We conclude that one or two doses of albendazole per year resulted in similar growth improvements, despite reinfection, in school-age children in an area where these helminths and poor growth are prevalent.

This was the first ever study of polyparasitism and growth in school-age children comparing the effects of an annual single or multiple dose regimen of an anthelmintic (albendazole). This was in an area where helminthic infections are highly prevalent but egg counts are relatively low.

Another study conducted in Kenya showed improvements in physical fitness in school boys infected with intestinal helminths following a single dose of 400 mg of albendazole. Physical fitness was determined using the Harvard step test (HST). School girls were not included because they were unable, or unwilling, to complete the exercise required for the HST. The primary school boys had baseline prevalence of infections of 91 % with hookworm, 94 % with *Trichuris trichiura*, and 40 % with *Ascaris lumbricoides*. They were examined, allocated at random to either a placebo or albendazole group, treated, and re-examined 7 weeks later (Stephenson, Latham, Kinoti, Kurz *et al.* 1990). The two groups did not differ significantly before treatment in age, anthropometry, hemoglobin levels, prevalence or intensity of the three helminth infections, or in initial HST fitness scores and heart rates. Seven weeks after treatment, the albendazole group ($n = 18$) exhibited significant improvements in fitness scores and heart rates at 1,2,3, and 4 min after the HST while in the placebo group ($n = 15$), these measurements had not changed significantly. Multiple regression analysis showed that the significant linear predictors of increase in HST score after treatment were decrease in resting heart rate after treatment, and decreases in hookworm egg counts and logarithms of *Ascaris lumbricoides* egg counts after treatment. It was concluded that a single dose treatment with albendazole, despite continual exposure to reinfection, can allow improved physical fitness in school boys in areas where soil-transmitted helminths and protein-energy malnutrition are highly prevalent.

This was followed by a study to determine whether actual physical activity improved after infected children were treated with albendazole (Adams, Stephenson, Latham and Kinoti 1994). Activity was measured using Kaulins and Willis Motion Recorders attached to children's legs. Determinations were done during three one-hour free play periods, and one structured play period, at baseline, and again 9 weeks after treatment. The study also examined changes in growth and appetite score as rated by the children on a five-point scale. The subjects consisted of 55 primary school children with high prevalences of hookworm (93 %), *Trichuris trichiura* (84 %), and *Ascaris lumbricoides* (29 %) at baseline. After baseline measurements, children were randomly allocated to the albendazole treated ($n = 28$) and placebo ($n = 27$) groups, and re-examined 9 weeks later (when the placebo group were treated with albendazole). Most indices of growth were significantly greater at the follow-up exam in the albendazole compared with the placebo group. After treatment, free play activity increased by 43 % for the albendazole group, and less than 1 % in the placebo group ($p < 0.007$). Structured play activity increased significantly for both groups at Exam 2, 53 % in the albendazole group and 33 % in the placebo group (not significant between groups $p = 0.28$). Self reported appetite improved significantly after treatment in the albendazole treated group ($p = 0.02$) and declined in the placebo group ($p = 0.06$).

Another study on physical fitness, appetite, and growth in Kenyan school boys was conducted, in part to confirm the findings from the previous one, but also to help explain them using different methodologies. In this new study, appetite was assessed with a new method based on actual food consumption and a higher dose of albendazole (600 mg) was used (Stephenson, Latham, Adams, Kinoti *et al.* 1993b). It had been shown that 400 mg of albendazole, although curing most hookworm and *Ascaris* infections, caused major reductions in *Trichuris* egg counts, but did not provide a cure. It was hoped to examine more closely the impact of treatment on hemoglobin levels, and to have a longer duration (4 months) between baseline and follow-up examinations. Four months after treatment the group receiving albendazole showed highly significant improvements in fitness scores, resting heart rate, and heart rates at 1,2,3 and 4 minutes after the strenuous exercise of the Harvard Step Test (HST). In contrast, the placebo group showed no significant change between baseline and follow-up examinations. Once more, it was shown that deworming resulted in significant improvement in physical fitness. And once again, it was also shown that the albendazole (600 mg) group of school boys had a highly significant more rapid growth compared with those receiving a placebo: weight gain ($p < 0.0002$); height increment ($p < 0.003$); and triceps and subscapular skinfolds ($p < 0.0002$). Hemoglobin levels at the baseline were not different in the two groups (albendazole 121 g/L; placebo 120 g/L). At follow up, the albendazole group showed no significant change in hemoglobin levels, whereas the placebo group had a significant decline to 114 g/L ($p < 0.0004$).

Breaking new ground, we assessed appetite using a test we had developed for this series of studies, and used successfully in a study on schistosomiasis (Latham, Stephenson, Kurz and Kinoti 1990). This test was appropriate for the culture, age group, and educational level of the subjects, and could easily and inexpensively be administered in a field setting. It is described in that paper as follows:

We chose a bland, commonly consumed local food (corn meal porridge, or *uji*) that would be acceptable to all subjects, and then used the most commonly preferred recipe, which contained 100 g of corn meal, 50 ml of whole milk, 62.5 g of sugar, and enough water added to yield 1 L of porridge. The porridge was thin enough to be drunk from a cup and to be measured in milliliters. It contained 2709 kJ/L. It was offered in unlimited amounts as a late-morning snack before and again 4 months after treatment. To determine whether food eaten at home on the morning of the porridge test influenced porridge consumption, the boys were asked to report quantities of all food and drink consumed between the time they got up that day and the administration of the porridge test. The energy content of their breakfasts was calculated by a nutritionist experienced in the nutrient content of local foods. Before the porridge test was administered, the boys were also asked to rate their own appetite on a 5-point scale as very poor, poor, average, good or very good.

Four months after receiving a single dose of 600 mg albendazole to treat their intestinal helminthic infections, this group of school boys reported consuming a mean of 386 kJ more than the placebo group for breakfast, and they consumed a mean of 122 kJ more porridge in the test setting than did the placebo group ($p < 0.05$). Some 41 % of the albendazole group increased their energy intake by at least 420 kJ after treatment, compared with only 19 % of the placebo group.

This finding, and that in several other similar studies by the Cornell group, is of great importance. It suggests that frequently, poor appetite may be as important, or a more important cause of poor growth and underweight in children, than are availability of food for the child, and family food insecurity. The fact that, in this study, improved appetite was concurrent with improved growth and increased physical fitness, demonstrates this point.

In so much of the nutrition literature, and in writings on pediatrics and childhood infections, it is stated that particular infections, diseases and conditions lead to poor appetite. But literature searches provide very few instances where appetite was determined in these conditions.

Schistosomiasis and nutrition

Of all the parasitic infections that affect man, schistosomiasis is one of the most widespread. In terms of socioeconomic and public health importance in tropical and subtropical areas, it is second only to malaria. It is one of the major occupational risks encountered in the rural areas of developing countries, and is second to none in prevalence among water-borne diseases (WHO 1985).

Schistosomiasis is endemic in 74 tropical developing countries. Over 200 million persons living in rural and agricultural areas are estimated to be infected, and 500-600 million persons are exposed to the infection amidst poverty, ignorance, poor housing, substandard hygienic practices, and few, if any, sanitary facilities. The prevalence of schistosomiasis is increasing in most endemic areas because the snail intermediate hosts spread as the new irrigation schemes and water conservation projects needed for economic and agricultural development provide them with new habitats. The prevalence estimates of the three species of schistosomes are as follows: *Schistosoma haematobium*, at least 78 million persons, *Schistosoma mansoni*, over 57 million, and *Schistosoma japonicum*, over 69 million, with some persons in Africa harbouring both *S. haematobium* and *S. mansoni*. (Stephenson, Latham, Kurz and Kinoti 1987).

The work of the Cornell group was mainly limited to research on *Schistosoma haematobium* which is a very prevalent infection on the Kenya coast, as it is in some 52 African and Eastern Mediterranean countries. This is urinary schistosomiasis, which often causes hematuria as a presenting symptom. Female schistosomes produce eggs which pass out in the urine. If these enter water, the eggs hatch to produce microcidia, which may then enter suitable snails. This develops to produce cercariae which leave the snail and may pass through the skin of a human in contact with the water. In the human, they develop and migrate, eventually developing into either male or female schistosomes, in veins around the bladder and urinary system. Females produce eggs, some of which are trapped causing pathology, including granulomas, and others pass through veins, damaging them and surrounding tissues, and passing out in the urine.

Haematuria and proteinuria are so common and easy to detect with modern methods, particularly in infected children in epidemic areas, that urinary reagent strips which semi-quantitatively measure haematuria and proteinuria are being used as screening devices to select infected persons for antischistosomal treatment, and to check them for re-infection. These methods are important because they allow treatment programs to reach more people

per day by saving much of the cost, time, and equipment needed for microscopic examination of the urine (Stephenson, Latham, Kinoti and Oduori 1984).

Urinary iron losses

In order to better define the nutritional importance of hematuria, and the contribution of *S. haematobium* to anemia in non-hospitalized school children, research was conducted in Kenya to study urinary iron losses. This was a sub-study of a larger one described below (Stephenson, Latham, Kurz, Miller *et al.* 1985). Three groups of children were included (low-medium egg count, high egg count, and uninfected) and were matched so they did not differ significantly in age, sex ratio, initial hemoglobin level, anthropometric measurements, or prevalence or intensity of other parasitic infections. Urinary iron loss was measured before, and 7 weeks after treatment with a standard course of metrifonate. Egg counts before treatment ranged from 16 to 177 *S. haematobium* eggs per 10 ml adj (adjusted for total urine specimen volume) in the low-medium egg count group, and from 200 to 1194 in the high egg count group (arithmetic means 91 and 512, geometric means 80 and 439, respectively).

Before treatment, the control group was losing a mean of 149 ug of iron per 24 hours, while the low-medium group lost almost twice as much (278 ug), and the high egg count group lost four times as much (652 ug). Iron loss in the high egg count group was significantly greater than in the control and low-medium groups. Iron loss per 24 hours was linearly related to *S. haematobium* egg count in the 33 infected children (Pearson $r = 0.40$, $p < 0.01$), and the log of iron loss was even more strongly correlated with the log of egg count (Pearson $r = 0.56$, $p < 0.0003$, $R^2 = 32\%$).

The high egg count group was losing approximately 0.5 mg more iron in their urine per 24 hours than the uninfected group. This finding has important implications for iron requirements of *S. haematobium*-infected children because it shows that iron losses in infected children can be comparable to menstrual blood losses in women. It is known that women between 15 and 45 years of age have increased needs for iron and a higher incidence of anemia than other groups of the population because of menstrual blood losses (Stephenson, Latham, Kurz, Miller *et al.* 1986).

Seven weeks after treatment with metrifonate, iron losses in the urine of the infected groups of children were not statistically different from iron losses in the urine of the uninfected control children. So good treatment appears rapidly to stop, or at least greatly reduce, iron losses in the urine.

Anemia and hemoglobin levels

The relationship of *Schistoma haematobium* infections to anemia had not been studied with a well-controlled longitudinal design before this was done in school children in Kwale District in Kenya (Stephenson, Latham, Kurz, Kinoti *et al.* 1985a). There had been several cross-sectional studies. The research described here studied the relationship between hemoglobin level and *Schistosoma haematobium*, hookworm and malaria infections, before and 6 months after, metrifonate treatment, in Kenyan primary school children in an area where anemia, *S. haematobium*, and hookworm were common (prevalences 61 %, 46 % and 95 % respectively), and malaria was holoendemic. The mean hemoglobin level in children from one school ($n = 250$) was significantly lower in children with higher *S. haematobium* egg

counts, heavier hookworm infections, positive *Plasmodium* slides, and larger spleens. All children with light to moderate *S. hematobium* infection (1-500 eggs/10 ml adj) in four schools were examined (Exam 1), allocated at random to either placebo (n = 198) or metrifonate treatment (n = 202) groups, treated, and examined again 6 months later (Exam 2). Hemoglobin levels rose significantly in both groups between examinations, but the rise in the metrifonate group was 30 % higher than in the placebo group (1.3 vs 1.0 g/dl, p < 0.014).

The increase in hemoglobin level in the metrifonate group was significantly and positively correlated with decreases between examinations in *S. hematobium* and hookworm egg counts, and with higher malarial parasite counts at Exam 1 (Pearson *r* values 0.21, 0.20, 0.20, respectively, p < 0.01). A stepwise multiple regression to explain hemoglobin rise between examinations showed that decreases in *S. hematobium* and in hookworm egg counts were equally important determinants of hemoglobin rise, and that malarial parasite count was nearly as important as the changes in intensity of the helminth infections. It was concluded that treatment for *S. hematobium* with metrifonate can increase hemoglobin levels in children in an area where *S. hematobium* and anemia are common. The results also emphasize the importance of measuring multiple parasitic infections and of using multivariate statistical techniques such as multiple regression analysis, in order to define the relationships between parasitic infections and morbidity.

Hookworm infection was particularly important to study in this area because of its high endemicity and because of our finding of metrifonate's effect on hookworm infection. The fact that metrifonate is partially effective in treatment of hookworm infection has been known for over 20 years, but the importance of this finding has not been sufficiently appreciated by those interested in decreasing morbidity with chemotherapy-based *S. hematobium* control programs. A standard three-dose course of metrifonate can produce hookworm cure rates in the order of 20 % and egg reduction rates of about 80 %. (Stephenson, Kurz, Latham, Kinoti *et al.* 1982; Kurz, Stephenson, Latham and Kinoti 1986)

Cure rates of this magnitude are poor, but the high egg reduction rates are sufficient to enable hemoglobin levels to rise so that the prevalence of anemia declines in areas where anemia and hookworm are common. Thus, treatment of *S. hematobium* infection, with metrifonate in particular, will decrease the prevalence of anemia by decreasing abnormal iron losses in the urine due to *S. hematobium* infection, and in the stool due to hookworm infection. Metrifonate for treatment of schistosomiasis has largely been replaced by praziquantel and other drugs not shown to have much impact on hookworm, or other intestinal helminths.

Child growth and adult weight-for-height

A study of road workers in Kenya was designed to find the prevalence of parasitic infections (intestinal helminths, *schistoma hematobium*, and malaria) and their interrelationship, and the impact of treatment and of malaria prophylaxis on anemia and nutritional status (Latham, Stephenson, Hall, Wolgemuth *et al.* 1982). Details are discussed elsewhere. One finding was that, following treatment with metrifonate, underweight males infected with *S. hematobium*, showed significant weight gain and gain in their percent weight-for-height.

The literature up to 1985, showed conflicting evidence when examining the relationship of *S. hematobium* to growth and nutritional status in children. Often intensity of infection was not considered or the studies were cross-sectional and could only show associations. The Cornell group saw the urgent need for research which would: (a) be longitudinal; (b) determine the intensity of infections based on urinary egg counts of *S. hematobium*, and (c) have a large enough sample to be able to control for confounding factors such as gender, age, socioeconomic status, presence of certain other infections, and dietary differences. With this in mind, a study was designed to examine the relationship of *S. hematobium*, hookworm, and malarial infections, to growth of Kenyan primary school children in an area where poor growth, *S. hematobium*, and hookworm were common, and malaria was endemic (Stephenson, Latham, Kurz, Kinoti *et al.* 1985b).

All children with light to moderate *S. hematobium* infections (1-500 eggs per 10 ml adj) in four schools were examined at Exam 1, allocated at random to either placebo (n = 198) or metrifonate treatment (n = 201) groups, treated, and examined again 6 months later at Exam 2. An additional 19 heavily infected children, with egg counts > 500 eggs per 10 ml adj, were treated immediately after Exam 1 and also followed. Both treated groups exhibited more rapid growth between Exams 1 and 2 than did the placebo group. The metrifonate group gained significantly more (p < 0.001) than the placebo group in weight (0.8 kg), percent weight-for-age (2.3 percentage points), weight-for-height squared (0.04 units), arm circumference (0.4 cm), percent arm circumference-for-age (1.7 percentage points), and in triceps and subscapular skinfold thicknesses. The placebo group showed statistically significant decreases between examinations in percent weight-for-age, percent arm circumference-for-age, both skinfold thicknesses-for-age, and no significant increase in percent height-for-age, while the metrifonate group exhibited highly significant increases in all anthropometric parameters.

Stepwise multiple regression analyses showed that poor initial nutritional status and the intensity of all three parasitic infections at Exam 1 helped explain the growth improvements after metrifonate treatment within the two treated groups, and that the relationships between initial nutritional status, intensity of infections, and subsequent growth varied for the different anthropometric measurements. The growth benefits due to treatment seemed to be maintained up to 16 months after the first metrifonate treatment, although it was not considered ethical to maintain an untreated placebo group for longer than 6 months, so the only untreated comparison group for the last 10 months of the study was a group of children without *S. hematobium* infection.

Physical fitness and other functional consequences

Earlier evidence showed that infection with schistosomiasis can reduce physical fitness, as judged by a step test (Jordan and Randall 1962). The authors reported poorer physical fitness in infected, than in uninfected, Tanzanian children. Treatment seemed to result in a greater increase of fitness scores in treated than in untreated infected children; however, the differences were not statistically significant. Unfortunately, the numbers studied were small and the authors did not separate less, from more, heavily infected children.

Twenty years later the Cornell group conducted a somewhat similar study with Kenyan primary school children, measuring the intensity of *S. hematobium* infections and matching children for possible confounding variables (Stephenson 1985).

The results showed that *S. hematobium* infected children were physically less fit, and had higher heart rates after completion of the Harvard Step Test, than did those uninfected. Children with high egg counts were significantly less fit than controls (mean scores of 69 vs 81); the group with low-medium egg counts also had a lower mean fitness score of 75, but was not significantly different from the control group. However, after treatment with metrifonate, physical fitness scores increased significantly in both the low-medium and high egg count groups, and were then similar to those of the uninfected group, whose scores had not changed; this suggests that decreased physical fitness in children is rapidly reversible with treatment. The low-medium egg count group did not differ significantly from the high egg count or from the uninfected group in heart rates or fitness scores. However, since their test scores were half way between those of the high egg count and the uninfected group, similar fitness tests should be repeated on a larger number of children to determine how heavy *S. hematobium* infection has to be before physical fitness decreases.

Spleen enlargement due to schistosomiasis

An enlarged spleen (splenomegaly) is very common in tropical populations. In studies by the Cornell group on the Kenyan coast, often 50-70 % of school children had some degree of splenomegaly. Many also had some modest increase in liver size (hepatomegaly). Generally tropical splenomegaly is believed to be due to frequent, or chronic, malaria infections. Others have associated this with some tropical diseases, including, *S. mansoni* and *S. japonicum*. These associations have been mainly in cross-sectional studies.

However *S. hematobium* infections have not been accepted as a cause of spleen and liver enlargement. In a study in Kenya, the cross-sectional association between infections with *S. hematobium* and spleen and liver enlargement were studied in 400 children from 4 schools who had *S. hematobium* in their urine (Stephenson, Latham, Kinoti and Oduori 1985). The children were randomly allocated to a treatment with metrifonate group and a placebo group. All examinations were done at the baseline and at follow-up, 6 months later. Malaria infection was assessed at both examinations using both thick and thin blood films. Urine was collected and intensity of infection based on *S. hematobium* eggs for 10 ml of urine was assessed. The spleen and liver size were assessed using abdominal palpation by a clinician (MCL). Spleen size was graded using the Hacket scoring method, and liver enlargement was expressed as centimeters below the midclavicular costal margin.

At Exam 1 some 41 % of children had malaria parasites in their blood films, and this did not change at Exam 2. All children in both groups received metrifonate treatment at Exam 2. At baseline 60 % of children had evidence of spleen enlargement and 16 % showed liver enlargement greater than 0.5 cm below the costal margin. Following treatment with metrifonate, spleen enlargement regressed significantly ($p < 0.0005$). In the placebo group spleen enlargement increased. There was also a modest regression of liver enlargement in the treated group, and a slight increase in hepatomegaly in the control group.

It was concluded that treatment of *S. hematobium* results in a very significant reduction in splenomegaly, while there was no change in malaria prevalence and mean malaria parasite counts. This is the first study to demonstrate that *S. hematobium* results in spleen enlargement.

Sensitivity and specificity of reagent strips in screening for *Schistosoma hematobium* infection

Schistosoma hematobium infects about 80 million people in Africa and the Middle East, and its prevalence is increasing. In most areas endemic for *S. hematobium*, successful control has not yet been achieved, and in many endemic areas, large scale control has not even been attempted. Since *S. hematobium* can result in irreversible urinary tract damage, can contribute to morbidity, and sometimes also to mortality, we must consider treatment and control of *S. hematobium* to be a public health priority.

Community-based chemotherapy, one of the most commonly used methods for treatment and control of urinary schistosomiasis, usually depends on diagnosis of individual cases by microscopic examination of urine for *S. hematobium* eggs. When considering mass treatment for urinary schistosomiasis, any screening method which selects out *S. hematobium*-positive cases more rapidly and cheaply than does microscopy should be considered because it is often both too expensive, or otherwise not feasible, to do hundreds of urine examinations for microscopic examination. The most promising screening method which avoids microscopy is based on the fact that the passage of eggs through the bladder wall produces hematuria and proteinuria. The degree of hematuria and proteinuria can be measured semi-quantitatively with enzyme-impregnated urinalysis reagent strips. Such test strips may offer an alternative but their reliability needed to be established.

Building on previous research on this topic, research was undertaken, to assess the reliability of urinalysis reagent strips to correctly select urine specimens found by microscopy to have *Schistosoma hematobium* eggs in 359 previously unscreened Kenyan primary school children (Stephenson, Latham, Kinoti and Oduori 1984). The presence of, and degree of, hematuria and proteinuria were highly correlated with the presence of *S. hematobium* eggs and with egg counts in urine specimens. Hematuria was more strongly correlated with *S. hematobium* egg counts than was proteinuria. The ability of the presence of hematuria or proteinuria, or both, to select all microscopically positive cases of urinary schistosomiasis for treatment was tested using sensitivity (ST) and specificity (SP) analysis. Selection of cases using 1) presence of hematuria alone, and 2) presence of either hematuria or proteinuria had the highest combined ST and SP (88 % ST, 97 % SP; and 91 % ST, 92 % SP, respectively). Most of the few cases detected by microscopy but not by reagent strips had low egg counts. The presence of hematuria alone failed to detect only 12 % of *S. hematobium*-positive cases (mostly low egg counts), and only 3 % of *S. hematobium*-negative persons had urinary blood and would have received unnecessary treatment.

This research, and that by several others, clearly shows the potential to use these, or similar test strips, in large treatment programs. Yet, as we move into the 21st century some countries have used mass treatment of schistosomiasis using praziquantel without any attempt at either diagnoses or assessment of blood in the urine (or stool).

Monograph on schistosomiasis and malnutrition

In 1986, a 192 page Monograph entitled *Schistosomiasis and malnutrition* was published (edited by Lani Stephenson). This contains a 26 page review on schistosomiasis (not only *S. hematobium*, but also *S. mansoni* and *S. japonicum*) and human nutrition. It is followed by a 50 page detailed presentation of research on the “Relationship of *Schistosoma hematobium*, hookworm and malarial infections and metrifonate treatment to nutritional status of Kenyan coastal school children: a 16-month follow-up” (Stephenson, Latham, Kurz, Miller *et al.* 1986).

The findings can be summarized thus: the study on hemoglobin level and growth in children 6 and 16 months after treatment has shown that those treated with a standard course of metrifonate and light-moderate infections of *S. hematobium* (1-500 eggs/10 ml adj) exhibited, when compared with a randomly assigned placebo group:

- Significantly better growth 6 months after treatment, judged by increases in weight (0.8 kg or a 50 % increase over placebo group), weight-for-height squared, arm circumference (0.4 cm), and triceps and subscapular skinfold thicknesses; these benefits appeared to continue for up to 16 months after treatment.
- Significantly larger increases in hemoglobin level 6 months after treatment (0.3 g/dl or 30 % increase).
- Within the treated group, children with higher *S. hematobium* egg counts, higher hookworm egg counts, higher initial malarial parasite counts, or poorer initial nutritional status (hemoglobin level or anthropometric measurements) showed the most improvement.
- Metrifonate’s effectiveness in reducing hookworm egg counts has major public health importance for areas where iron deficiency anemia, hookworm infection, and *S. hematobium* infection are highly prevalent, although reinfection will occur.

The study of urinary iron loss and physical fitness showed that:

- Children with relatively high *S. hematobium* egg counts (> 200 eggs/10 ml adj) lost 4 times as much iron in their urine as did uninfected children, and those with low-medium egg counts lost about twice as much iron. Iron loss in infected children was linearly related to egg count, and extra iron loss in the relatively heavily infected ones (0.5 mg/day extra) is high enough to produce anemia in many tropical populations. The high egg count group represented over 12 % of the infected children in grades 1-4 in this area of Kenya, so *S. hematobium* clearly can contribute significantly to anemia in endemic areas, particularly if dietary iron intakes are low and other pathological causes of anemia, such as hookworm infection and malaria, are prevalent. However, urinary iron losses return to normal levels in infected children very soon after a standard course of metrifonate.
- *S. hematobium* infected children were less physically fit and had higher heart rates when performing the same amount of work than did those uninfected.

Children with high egg counts were significantly less fit than controls; those with low-medium egg counts also had lower fitness scores but were not significantly different from controls. However, after treatment with a standard course of metrifonate, physical fitness scores increased significantly in both the low-medium and high egg count groups and were then similar to the values of those uninfected, while scores did not change in the uninfected group, showing that decreased physical fitness is rapidly reversible with treatment.

It was concluded that metrifonate treatment of even light and moderate infections of *S. hematobium* results in a much greater improvement in general health status of children than was previously thought. *S. hematobium* infection can cause enough urinary iron loss to precipitate or aggravate anemia in children, particularly in areas such as the Kenya Coast where other parasitic causes of anemia are prevalent and/or dietary iron intakes are inadequate. Treatment of *S. hematobium* infected anemic children will improve their hemoglobin levels. Treatment of *S. hematobium* infection with metrifonate may improve child growth and physical fitness in areas where protein-energy malnutrition and hookworm infection are common. While heavy *S. hematobium* infections are likely to respond most to treatment, children with light and moderate infections will also benefit from being treated, and deserve to be treated. More widespread use of population-based chemotherapy to control urinary schistosomiasis and hookworm infection, and appropriate measures to control malarial infection in communities with high prevalences of protein-energy malnutrition and/or anemia, are clearly needed.

The last 120 pages of the monograph describe and present results of a household and ethnographic survey in the area where high prevalence rates of schistosomiasis had been found on the Kenyan coast, and where studies had shown their important impact on nutrition and health (Stephenson, Elliott and Kinoti 1986). The major objectives of the analysis of the household survey, and ethnographic data were to describe in detail the community's knowledge about schistosomiasis, their water resources, and sanitation, and to answer the following specific questions:

- Do primary school children with *S. hematobium* infections and their mothers know less about the cause, prevention and treatment of *S. hematobium* infections, than those uninfected and their mothers?
- Do the infected and uninfected groups differ in socioeconomic indicators, including father's occupation, household size, construction of house, or fieldworker's assessment of income level?
- Do the two groups differ in access to, or reported utilization, of all water resources including: water sources used in dry and wet seasons, amount available per household member, time needed to fetch water, distance of household to marsh, and mother's report that child goes to marsh to bathe, wash clothes, draw water, or play?
- Do children who come from households which have latrines differ, from those who don't have latrines, in prevalence or intensity of hookworm or *Trichuris* infections?

After all, in the long term, it is important to devise and introduce actions to reduce transmission of parasite infections, not to rely just on treatment. Such actions might not only reduce the prevalence of helminthic infections, but also the incidence of diarrhea and other infections. To control these infections it is important to investigate knowledge, attitudes and practices in the community.

The survey data show that most mothers and children either said they didn't know (and were perhaps confused) about causation and prevention of schistosomiasis, or they gave medically incorrect answers. In either case, the implications for control of *S. hematobium* are the same: neither mothers nor children know enough about the disease to prevent getting it through behavioral change. Over half, or 55 % of the parents questioned (mainly mothers), stated they did not know what caused *S. hematobium* infections. Only 19 % knew that people get the infection by standing in infected water, 24 % thought it came from drinking "dirty" water, and 2 % stated that one caught the infection by eating hot peppers, or too much sugar. Higher percentages of mothers of uninfected vs infected children stated that bilharzia was caused by standing in "dirty" water (24 % vs 14 %).

In investigating water use it was found that the main water uses are drinking, cooking, washing dishes, washing clothes, and bathing. In addition, children play in marsh water, and small amounts of water are used to make mud or cement for houses, and for ritual ablution. Marsh water is used mostly for washing and is only used for drinking or cooking when other nearby sources (water holes) dry up. The marshes are a common play site for children, and many adults bathe and wash clothes there.

The survey showed that a significantly higher percentage of households of infected children reported having small amounts of water per person per day (5.0-9.9 liters/person) than did households of uninfected children (35 % vs 20 %), while 22 % of both groups of households reported a high daily water use (16.0 - 37.9 liters/person; Kendall Tau C $p = .044$). This difference implies that *S. hematobium*-infected children from the households with low water availability may go to the marsh area to bathe either because there is little water available at home, or because they want to spare the mother the effort of fetching additional water and can enjoy playing in the marsh at the same time. The mean quantity of water available per person per day for all 85 households was 13.1 liters.

Mothers were asked whether or not their study child used the marsh area (where *S. hematobium* infection is transmitted) for any of five purposes: bathing, washing clothes, drawing water, playing, or any other purpose. Their responses were analyzed between and within study groups for differences in reported marsh contact by sex, age group, distance from the household to the marsh area, household water use, and income level. A significantly higher proportion of mothers of infected, as compared with uninfected children, reported that their child used the marsh for at least one purpose (57 % vs 33 %, $X^2 p = .026$), and higher proportions of infected children reportedly used the marsh for each of the five purposes mentioned, including bathing (43 % vs 18 %, $p = .009$), washing clothes (41 % vs 27 %, ns), drawing water (30 % vs 16 %, ns), playing (36 % vs 24 %, ns), and other purposes (20 % vs 10 %, ns). Infected children reportedly used the marsh for a mean of 1.7 activities per child, while the mean for uninfected children was only 0.9 activities per child ($p = .014$); 27 % of infected children were reported to use the marsh for 4-5 activities, compared with only 9 % of uninfected children ($p = .036$). These findings are important because they show

that many mothers knew that their children had contact with the marsh, and the children who were infected were also reported to use the marsh more than the uninfected ones. Nevertheless, 33 % of the uninfected children reportedly used the marsh but did not have patent *S. hematobium* infections in two urine examinations done 6 months apart.

Concerning latrine availability in the study area, the ethnography revealed the following major points:

- Very few households have latrines.
- The main obstacles to building them are rocky soil that is hard to dig up, or sandy soil which collapses, and the high cost of hiring someone to build them.
- There is a wide understanding that people should have and use latrines.
- This understanding is not held firmly enough to overcome the obstacles of sandy and rocky soil.
- People do not like to talk about latrines.

About 75 % of the 85 households interviewed for the survey did not have a latrine. The presence of latrines, and the reported defecation sites for pre-school and school children, did not differ significantly between the two study groups, although a higher percentage of *S. hematobium* infected as opposed to uninfected children came from households where the respondent stated that pre-school and school children defecated in the bush and not in the latrine.

Schistosomiasis in Egypt

Research was conducted in Egypt by Samia Ibrahim for her Ph.D. with Michael to investigate the relationship between schistosomiasis, food intake, nutritional status and cell mediated immunity in primary school children (Ibrahim 1992). The research was a cross sectional study which included 570 children in 2 Egyptian villages. Children infected with *S. hematobium* had poorer nutritional status than uninfected children; their food intake was lower, but showed no significant difference in cell mediated immunity as judged by a tuberculin test.

Parasite studies in adult Kenyans

Most of the studies in Kenya by the Cornell group investigating the impact of helminthic infections on nutrition were conducted in children (Latham, Stephenson, Kurz and Kinoti 1990). In 1975 Michael received a grant from the World Bank to conduct research in adult road workers in Kenya. These workers were employed in the Rural Access Road Program. The World Bank and ILO were assisting the Kenya Ministry of Works to construct rural roads to provide access, usually to agricultural areas lacking a road. Another objective was to use manual labor in preference to mechanical or motorized techniques. This type of labor intensive road building reduces the need for foreign exchange and also provides local employment. Our research was to investigate the relationship of nutritional and health factors to the productivity of men and women employed on road construction (Latham 1983).

The design and results of these studies conducted in four regions of Kenya (coastal lowlands; central highlands; Lake Victoria basin; and the semiarid remote North West) are described in chapter 10 of this Monograph. The nutritional status, parasitic infections and general health of 801 male road workers, were investigated. After a clinical exam, stool and urine examinations were done; blood slides in some areas were examined for malaria parasites, anthropometry was used to judge nutritional status, and sometimes dietary information was collected. An early cross sectional study was conducted to compare nutritional status, parasitic infections and health of male road workers in these four geographic areas of Kenya (Latham, Stephenson, Hall, Wolgemuth *et al.* 1982).

Undernutrition was common in all areas but was most marked among men in the semi-arid area. Anemia was most prevalent in the coastal lowlands where 41 % of men had a hemoglobin level less than 13.0 g/dl. Hookworm eggs were seen in the feces of 40 % of all men and in 69 % of samples collected in the coastal lowlands. The Lake Victoria basin was a significant focus of infection with *Schistosoma mansoni*, 51 % of fecal samples containing its eggs; *S. hematobium* also occurred but was most common in the coastal lowlands. Stages of *Plasmodium spp.* were most commonly observed in blood smears collected from men near Lake Victoria and the coast, two significant foci of malaria. An analysis of variance used to examine the relationship between variables indicated that the most significant association was between hookworm infections and low hemoglobin levels.

In many of these studies in different areas of Kenya low worker productivity was strongly associated with anemia and with low weight-for-height. The anemia and its severity were often related to parasitic infections. This was studied in more detail in 150 male road workers in Kwale District (Latham, Stephenson, Hall, Wolgemuth *et al.* 1983). At the baseline examination, 59 % were infected with hookworm (mean of 227 epg \pm 541), 38 % had infections of *Schistosoma hematobium* (mean 52 \pm 82 ova per 10 ml urine), 23 % had a blood film positive for malarial parasites, 47 % had anemia (Hb below 13 g/dl), and 31 % had a percentage weight-for-height below 80 % of a reference value for healthy men. It was found that anemia was significantly associated with hookworm infections and egg counts. Three interventions were evaluated: providing pyrantel pamoate for hookworm to all men, treating the *S. hematobium* infections with metrifonate, and giving weekly chloroquine prophylaxis for suppression of malaria to one group of men. A final examination conducted 16 weeks later showed a significant improvement in hemoglobin levels in anemic men treated for hookworm and in those receiving chloroquine, compared with those receiving placebos. Multiple regression analysis revealed that a) both hookworm and *S. hematobium* egg counts were associated with anemia at the baseline examinations; b) factors related to the treatment of hookworm and prophylaxis for suppression of malaria were related to hemoglobin increases in anemic men; and c) successful treatment of urinary schistosomiasis was associated with weight gain. The feasibility of the interventions was good and the costs moderately low.

This, and other studies conducted by the group in Kenya, did not prove that infections with intestinal parasites, schistosomiasis, and malaria lower worker productivity. They did demonstrate that simple attention to food intake, iron status and parasitic infections lead to measurable significant increases of productivity of employed workers. It is not too large a

leap to suggest that this could almost certainly improve the productivity of farmers on whom most non-industrialized nations depend for their economic development.

Popularity of deworming

In almost all the research conducted on parasitic infections, deworming has been a feature, and large numbers of pre-school age children, school children and adult road workers have received effective non-toxic easy to take anthelmintic medicines. One finding from all these studies, and those conducted elsewhere, is that deworming is very popular (Stephenson, Latham, Kurz and Kinoti 1987). School principals do not wish the research project to end because they wish to continue having their pupils dewormed stating that it improves school performance and attendance; teachers from neighboring schools not included in the project ask that their schools be dewormed; mothers of pre-school children not included demand deworming for their children; and adult road workers and others in rural communities flock to our study sites asking for treatment.

This was found to be true also in Tamil Nadu in India where, as part of a study on growth monitoring, routine deworming of 453 pre-school children was carried out in 12 villages using albendazole administered at home by female fieldworkers (Ramakrishnan, Latham and Abel 1995). Deworming was reported to be “extremely popular”. Some 99 % of mothers perceived it as beneficial for their child’s health and many also reported improvements in the appetite of their children following deworming.

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Chapter 4 - Hunger in America: research and advocacy

Michael Latham, with his Cornell appointment as Professor in International Nutrition, has concentrated his research on problems in the non-industrialized countries of the South. With only a few exceptions, he has not himself, or through his students, conducted research on nutritional problems in the United States. However, whether in his writing, in invited talks, or in testimony before the US Senate and Congress, he has strongly advocated for addressing, and reducing, hunger in the United States.

One exception was a series of studies, in collaboration with Dr. Daphne Roe, on nutrition and health of welfare women in Upstate New York. This involved collecting clinical, dental, dietary, and other data in middle aged women on welfare in several communities in Tompkins County (Roe, Latham and Eickwort 1973). Many nutrition graduate students acted as research assistants with Daphne Roe and Michael, going out in the evenings to rural community centers and churches where welfare women had assembled and were examined. These women showed much undiagnosed hypertension and diabetes, very poor diets, and a huge amount of untreated dental caries and periodontal disease. Some 55 % of those 50-60 years of age were totally edentulous and few had adequate dentures. Women still having teeth required an average of about 1200 dollars of dental treatment (in 1974 US dollars), and many lived in areas where not a single dentist would treat welfare women (Roe, Eickwort and Latham 1973).

White house conference

The 1969 White House Conference on Food, Nutrition and Health was the only one of its kind ever held. Michael was appointed to serve as Co-Chair of one of six special panels. This was perhaps the most diverse and interesting panel: it was investigating the nutrition of “the groups for which the federal government has special responsibilities”. They included the inhabitants of the District of Columbia (Washington D.C.), the military, migrant workers, so called at that time Indians, Eskimos and Alaskan natives, the residents of the US Caribbean islands (Puerto Rico and the Virgin Islands), and finally inhabitants of the Pacific group of US islands (Guam, American Samoa, and the US Trust Territories). Members of all these groups were consulted and interviewed (Bode, Gershoff and Latham 1974). Very different, but often serious, nutrition related problems, were noted in each of these diverse groups of people who were either US citizens, or living under US control for various, sometimes historical, reasons. Yet, they were not always eligible for food and other assistance available to the 50 United States (Latham 1973a).

Washington D.C. was found to have an infant mortality rate as high as 44 per 1000 live births in poorer areas of the district, almost twice as high as the national average. It also showed high rates of anemia, particularly in children (65 % of those below 18 months of age in one poor neighborhood), and a generally deprived situation, yet with no state’s rights.

It was perhaps surprising to discover that undernutrition was a problem among the “military poor” who may have numbered 250,000, with over 50,000 soldiers, sailors and airmen having military salaries below the poverty line. As a result of the evidence we presented at the White House Conference, commissaries on military bases were later authorized to accept food stamps. Our panel also reported that the US Department of Defense had often contributed to hunger and malnutrition. We gave the example of “the use of herbicides in Vietnam for destruction of rice and other food crops” which had “substantially contributed to hunger and malnutrition (and to death and disease) among civilians in Vietnam”(Latham 1973a). We proposed that starvation be banned as a weapon of war. The report also condemned the US Department of Defense for increasing its purchase of grapes during the long strike of California grape pickers, led by Cesar Chavez.

The panel study of the 2.5 million migrant and seasonal farm workers in the United States revealed that they had the lowest mean annual income of any working group. The panel stated that the US government “provided billions of dollars in agricultural subsidies while largely ignoring the social and economic problems of those who harvest the crops”. The panel condemned the wide use of child farm labor (26 % of all migrant workers were children), and reported on many studies showing serious nutritional problems in both adults and children.

In a quite detailed review of the nutrition and health situations of American Indians and Alaska natives, high infant mortality rates were revealed as well as the fact that about half the American Indians lived in houses with no running water, and many in desperate poverty. A report from Tuba City Hospital indicated a high case fatality rate among many Navajo children admitted with kwashiorkor and nutritional marasmus. Other reports showed extensive anemia, significant underweight in many very young children, and yet prevalent obesity in older persons.

The panel reported on similar nutritional problems related to poverty and lack of autonomy among the US Pacific populations of Guam, Samoa and the Trust Territories, and also in Puerto Rico and the Virgin Islands of the Caribbean (Latham 1973a).

The McGovern senate committee

Prior to the White House Conference on Nutrition, and following reports of much hunger particularly in the southern United States, in 1968 the US Senate established a Select Committee on Nutrition and Human Needs under the chairmanship of Senator George McGovern. Michael was one of three nutritionists to be a witness and give a presentation on the very first day it held hearings (Latham 1968). In his testimony, he pleaded for US programs to assure reasonable incomes for the poor, in preference to subsidized or free foods. He pointed out that among 16 industrialized nations with better infant mortality rates than the United States, none had specific food programs for the poor, but rather they took care of them with adequate welfare programs to raise their income. He suggested that if the food programs were to remain in place in the United States, they should be under the jurisdiction, not of the United States Department of Agriculture (USDA), but of the then Department of Health, Education and Welfare. He stated that there was “a conflict of interest in having the same department looking after the interests of farmers, and feed our poor and our children. Food programs should all be based on nutritional needs not on food surpluses”.

In 1971 Michael was invited again to testify before the US Senate Select Committee on Nutrition and Human Needs, this time in regard to the US Direct Distribution Program, often called the Family Food Commodity Program. Michael had stated in testimony that he believed the program “conceived in 1935 was sick, indeed moribund and would soon be buried”. His report stated that this seemingly moribund program might not soon be buried, because “certain politicians and vested interests will continue to fight for its retention” (Latham 1971).

As well as doing an analysis of foods and nutrients in the food commodity program, Michael worked with Dr. Lillian Emmons and Dr. David Call, at Cornell, conducting a detailed study of the program in Tompkins County. They showed that food commodity recipients were getting about half the energy and protein claimed to be provided by USDA. The conditions of distribution and the views of the recipients were also studied in some detail revealing that for eligible families to get food commodities

...may involve problems of transport, of child care, of losing work and pay, of long waits, of shivering parents and half frozen children, of indignities and being pushed around, of fighting a bureaucracy, and at the end of the line finding items you are entitled to are unavailable.

Finally the report to the US Senate Committee (Latham 1971) provided 13 recommendations for changes in the Food Commodity Program. It also stated that “it is a bad program and should be entirely replaced by some scheme which would assure an adequate income for the poor. A program giving away surplus foods tends to demean the poor.” The report also drew attention to the neglect of some diseases that are especially prevalent among those who are black, or who are poor, including lead poisoning, sickle cell disease, and of course, undernutrition.

Breakfast cereals – costly convenience not better nutrition

In 1970 Robert Choate, a moderate Republican philanthropist and occasional Washington lobbyist, who assisted in the organization and running of President Nixon’s 1969 “White House Conference on Food Nutrition and Health”, caused a furor when he issued a scathing report on the breakfast cereal industry. He had worked for some time on the topic of media advertising to children and had conducted his own analysis on the advertising, and the nutritional quality of breakfast cereals in the United States. He pointed out that adding sugar or marshmallow bits, and making breakfast cereals sweeter, might appeal to children, especially as advertised, but reduced their nutritional value. Children were being attracted to them, and parents were being hoodwinked.

The United States Senate Committee on Commerce decided to hold hearings on the topic. They invited Michael to conduct his own review on the nutritional value and cost of breakfast cereals and to testify before them. Michael used USDA Food Composition Tables to examine the energy, protein, calcium, iron, vitamin A, thiamin, riboflavin, niacin, and vitamin C content of popular breakfast cereals, and compared these to common cereal based foods such as bread, rice and corn grits (Latham 1970). The results were presented to the US Senate Committee on Commerce in an 18 page report including tables showing the

composition per 100 grams of these nine nutrients, comparing the price per pound, and the grams of protein that can be purchased for 10 US cents.

The conclusion was that breakfast cereals are good foods but that those breakfast cereals sold in greatest quantity are not nutritionally superior, and in some respects are nutritionally inferior, to many very common and much cheaper foods such as bread, rice, beans and corn products. The public is unaware of this, for the advertising tactics of the industry have, in an indirect and subtle way, misled the consumer. A special advertising onslaught has been made on our children. It seems that the less nutritious breakfast cereals and those that are sweet are especially being peddled to the young.

Breakfast cereals vary greatly in their nutrient content but most of them do provide reasonable quantities of some nutrients as well as calories. However they are more expensive and on the whole not nutritionally superior to bread, rice or grits. It is perhaps regrettable that the term "cereal" has come to mean "dry breakfast cereal", and that advertising has led the consumer to believe that ordinary breakfast cereals are nutritionally superior to wheat, rice and corn products. They are not.

If the lay public are told of a child in India getting nothing but a bowl of rice for breakfast they would probably conclude that this was nutritionally a very poor breakfast. However 1 ounce of rice contains about twice as much protein and more calcium, iron and thiamin than does 1 ounce of a puffed rice breakfast cereal. Puffed rice is five times as expensive yet provides smaller amounts of most nutrients than ordinary rice.

So breakfast cereals provide costly convenience, not better nutrition. For busy mothers, convenience may be very important, but advertising should not make false claims, and certainly should not be bombarding children with advertisements. It has been reported that 50 % of all the nation's 2 to 11 year olds are in place before their TV sets every Saturday morning instead of in parks and playgrounds, or doing something that is intellectually stimulating. TV advertising is powerful. The report stated that breakfast cereals are no more the food of champions than are bread, corn or rice. Yet, ask any 8 year old on your block, or almost any suburban housewife, and you will be told that breakfast cereals are better nutritionally than bread, or rice, or baked beans. These consumers did not get this idea from their health education classes, or nutrition textbooks, or from news articles, they got it from the skillful advertising of the breakfast cereal manufacturers.

It is Tony the tiger of certain frosted flakes saying "Go, go, go;" it is Kellogg's sugar pops claiming to be a wild cat of a cereal while showing a handsome cowboy on his horse; it is Cheerios advertising itself as the cereal with protein and energy with a visual background of a healthy youngster on a trampoline; it is "super power with sugar crisps" with the cartoon hero parting the iron bars of a window indicating the strength it gives; it is all these kinds of claims which give the public a false idea of the superior nutritional qualities of the breakfast cereals (Latham 1970).

One recommendation made in this testimony and report was that the nutrient content of breakfast cereals be provided on the package, something that is now in place.

US actions related to famine and starvation

The Nigerian civil war.

In 1970, the civil war, often called the Biafran war, came to an end thus concluding the secession attempt by mainly Ibo people in Eastern Nigeria. Upset by what they felt was neglect by the central government in Lagos, a “rebel group” set up a secessionist state they called Biafra, with the apparent acquiescence of most Ibos. A bloody war followed. For many months Biafra was more or less surrounded and isolated, and became dependent on its own resources and on assistance from charitable NGOs. Pictures of starving marasmic Ibo children in newspapers and on TV screens had their impact. Biafra gained a good deal of sympathy from people in Europe and North America, but not official recognition by western states.

At the close of hostilities there seemed to be little data, and no clear picture, as to whether starvation was a major problem in the besieged enclave, or whether the Biafran leaders had used starvation as a means of eliciting western support and sympathy. As a result donor countries were uncertain how much food and other assistance was necessary.

Two days after the end of hostilities, Michael, then on a short assignment for WHO in the Philippines, was told to “come to the phone as Henry Kissinger is calling you”. Unlikely? But it was, and Kissinger, then White House Chief of Staff for President Nixon, was asking Michael to go “immediately to Nigeria and Biafra to assess the nutritional situation and report to the White House within 10 days to assist our government to decide how to act.” A few days later, in former Biafra, now only relatively peaceful, Michael conducted a truly rapid assessment, including some random weighing and measuring of rural children in scattered areas and some urban children in the town of Owerri, visits to markets and food stores, inspection of pediatric wards in hospitals and of children attending clinics, and so on. Michael wrote a long report for Henry Kissinger and the White House concluding that serious malnutrition was prevalent and that short term food assistance and health attention, though important, should only be provided if the central Nigerian government did not do this on his own. The “report” ridiculously still remains “classified”.

Michael used data collected in the Nigerian famine in a paper advocating the use of an anthropometric method to distinguish between what was termed current acute malnutrition and past chronic malnutrition, now termed wasting and stunting. The paper compared anthropometric data from this acute situation in Eastern Nigeria, with the more chronic undernutrition found in the FAO supported National Nutrition Survey in Zambia, for which Michael had been a consultant. The Nigerian data collected in the rapid survey showed 39 % of children aged 0-5 years of age with severe wasting compared with 4 % in Zambia (Latham 1973b). However in terms of past chronic malnutrition, or stunting, some 17 % of the Nigerian sample and 51 % of the Zambian children had moderate or severe stunting. The paper was written before nutritionists separated children based on anthropometry using terms now widely accepted such as wasting and stunting. It stated:

The need to make distinctions between past chronic malnutrition and current acute malnutrition has not been adequately recognized. It is not an academic matter, but has real practical implications. It is important both in terms of designing

appropriate nutrition policy and intervention programs, and in terms of the prognosis and the possibilities of success of applied nutrition activities.

For example, the large group of Zambian children classified as having past chronic malnutrition would in most surveys have been classified as having first, second or third degree malnutrition using the Gomez classification based only on weight-for-age. They would not have been separated from the other two groups where the malnutrition is acute. Yet a nutrition supplementation program is unlikely to improve the status of these children. The proposed classification permits health and other nutrition workers to distinguish those children who have the greatest likelihood of benefiting from supplementation or other nutrition intervention programs from those who are unlikely to benefit very much.

In contrast, where the majority of children have marked deficits in weight-for-height, improved intakes of calories and protein can be expected quite rapidly to improve nutritional status. This was the case with children affected by famine in Nigeria (Latham, 1973).

The Sahelian famine.

A few years later, following several years of drought, the world was seeing pictures on their TV screens of starving children from countries just south of the Sahara, including Mauritania, Mali and Senegal. Senator Edward Kennedy, as Chair of the US Senate Subcommittee on Health, asked Michael to serve as nutritionist on a small team from the Senate which included two public health specialists, to make a rapid assessment and report back to the Senate. The team visited several sub-Saharan countries. US Senate hearings were held in Washington on June 10 and 11, 1975 where Michael presented his report and answered questions from US Senators.

The 26 page report and testimony allowed not only a presentation on the situation in the sub-Saharan countries, but also concerning US neglect and misunderstanding of Africa (Latham 1975). The report used existing data, as well as personal observation, especially for example from Mauritania where huge informal settlements of refugees from the desert had gathered around the capital city Nouakshott. This almost doubled its population, but most had no job, no means of support, and had lost almost all their livestock. The good rains of 1974 would bring only limited relief because so much of the population were dependent on livestock, and had lost almost all of these. Some two thirds of displaced persons saw no hope of returning to their previous life.

In Mali, the situation differed markedly from that in Mauritania. Traditionally, nomadic people, mainly Touaregs and Fulanis who are a small minority of the population in Mali, are the groups having the most severe after effects of the years of droughts. In 1972 and 1973, with the loss of most of their cattle and camels, these proud and independent people had to abandon their nomadic lifestyles, and in a depressed state, were crowded into disorganized squatter villages and settlements. But the Malian government later organized camps with quite sound feeding programs. Assessments of the situation on the ground, around Timbuktu and Goundam in the north, showed camps with reduced populations as people had returned to the desert, and others beginning to cultivate, large stockpiles of rice, and flourishing markets with a wide variety of foods (Latham 1975). The hospital in Timbuktu was not seeing an undue number of severely malnourished children. Based on

viewing the situation, on holding extensive discussions in Mauritania, Senegal and Mali with several Ministers and high government officials, and on holding meetings with UN and NGO staff responsible for “drought relief”, the report recommended continuing US assistance by stating:

It is tempting for the countries and agencies who provided much of the relief, and even for the countries themselves, to adopt the view that the drought, the famine and the resulting effects are now over, and that little more needs to be done. That is far from the truth, and I must be categorical about that, because increased not decreased assistance is needed. There has been one year of adequate rain in most areas, and it is to the credit of the governments and the farmers that good use was made of that rainfall. The situation for many subsistence farmers was better last year. But although the longed for rain fell like manna from the skies there was no downpour of cattle, camels or goats. Therefore the position of those, especially the nomads, who are dependent on livestock, is only a little better in the 1974-75 crop year than in the disastrous year of 1973-74. The rains came last year, but we do not know yet whether they will come this year. Even if rains are good again this year, there are still huge remaining problems that were created by the years of famine and drought; there is a tremendous need for short and long term development assistance; and mammoth efforts are required to help prevent a similar disaster from hitting the Sahel in the future.

The Sahelian patient, to use a medical analogy, is showing great resilience and recuperative power, having survived a long and desperate illness, one which required major surgery and massive transfusions. Let us not abandon the patient before he is even out of the recovery room. But instead, let us assist this recovery, and then help with rehabilitation and with the aid needed to allow him to become productive and fully self-supporting in the future. If we do not do this, we will have largely wasted the money we spent on the initial, rather radical, therapy. The U.S. as a country has the good reputation of rushing in to help in times of emergency but needs also to show that it has the staying power to provide continuing development assistance after the drama of the emergency is over (Latham 1975).

The testimony to the US Senators and the printed report also allowed Michael to be critical of the US neglect of Africa, as viewed by him in 1975. The publication of the Senate Hearings includes this statement (Latham 1975).

There is no need for me to document to the subcommittee the very clear evidence that shows that the United States has and continues to use its food assistance not only for political purposes, but also for military ones. How we use our food aid is a question of the greatest importance. Undoubtedly, the U.S. Government will continue to give more food assistance to friends than to enemies, but let us be straightforward and honest about this. It is my view that a large proportion of our food assistance should be allocated on humanitarian grounds, and that priorities should be set largely on the basis of human needs.

Early in the testimony it is stated that

At the outset I wish to be harshly critical of the dire neglect that the United States in particular, and the industrialized countries in general, have demonstrated with regard to Africa. If the United States has shown “benign neglect” to its own

black citizens, the neglect of Africa has been deliberate, has been harsh in its consequences, and has even at times been malignant. No other continent is so misunderstood by Americans and so ignored by this government... As the United States turns away from its unwise and tragic involvement in Vietnam this may be a very opportune moment for the government to reassess its priorities in foreign policy, in terms both of geographic areas deserving attention and help, but also of the criteria used for deciding what assistance should be given (Latham, 1975).

US dietary goals and international dietary guidelines

In 1976, for the first time a set of Dietary Goals were introduced for the United States and caused considerable controversy. The Society for Nutrition Education (SNE), where Michael was a Board Member, wanted to publish papers for, and against, the Goals. In the invited *pro* goals paper, an argument was made in support for the concept of the goals as a public health measure (Latham and Stephenson 1977). It was stated that

...we do not agree entirely with each figure recommended, nor that there are not other important goals that could be proposed.... but nutritionists argue endlessly about RDA levels, yet support having RDAs. Goals were set, based on current knowledge, and need to be frequently reviewed and changed on the basis of new research findings. But, if we do not agree with setting nutrition goals, at all, how can we favor nutrition education and support the objectives of SNE?

More than a decade later, the United States had adopted official USDA Dietary Guidelines. Again the Society for Nutrition Education (SNE) was much involved regarding how these could best be used to educate Americans about their optimum diets. SNE had by then established a new International Nutrition Education Division. Some in this Division began a review of Dietary Guidelines in other countries, north and south, but most of them were from industrialized countries. Most other guidelines agreed on certain points such as avoiding consumption of too much fat and salt. SNE's International Nutrition Education Division organized an International Congress on Dietary Guidelines, largely managed by Peggy Koniz-Booher, and chaired by Michael Latham. The Congress held in Toronto, Canada, in 1988, brought together leading nutritionists from around the world including such figures as Dr. Gopalan from India and Dr. Scrimshaw from MIT.

In examining Guidelines from other countries, and comparing those with the US Dietary Guidelines, it was apparent that the latter were rather generally "prescriptive", and though perhaps appropriate for the majority, did not accommodate a moderately large minority; compared with other guidelines, they were more negative than positive. For example, recommending a reduction of fat consumption; sugar consumption and salt consumption. A group at the meeting in Toronto produced, and presented to a plenary session, a set of international guidelines that seemed more positive, and that could be universally applicable. Those took note that "eating less fat" for many people in the world was inappropriate. Some persons would benefit from consuming more fat. So a universal guideline could state, "Fat consumption should provide at least 15 % of energy from fat, and less than 25 %". The recommendation for salt could be "salt consumption should be less than 3 grams a day" (Latham and van Veen 1989).

The international delegates and many of the academics at the Congress supported these International Dietary Guidelines, but a large group of delegates representing USDA and other US government agencies, and many food scientists from the commercial food industry, strongly opposed them. Some of the opposition was about one or two specific guidelines, because of lack of clear scientific “proof”, but the main objections were that USDA and the US government (Ronald Reagan was then President) could not accept international guidelines. So, although these international guidelines influenced those in many countries, they went nowhere in the United States.

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Chapter 5 - Infant feeding and breastfeeding

Introduction

During most of his professional career Michael Latham has been a strong advocate for breastfeeding, and an aggressive opponent of the promotion of infant formula. Perhaps the first published record of that can be found in a keynote address he gave 45 years ago at the *6th International Congress of Nutrition* in Edinburgh in 1963. He stated:

A new and serious problem which has been introduced to Tanganyika is pernicious advertising [of infant formula...]. Among the majority of people in Tanganyika the commencement of bottle-feeding is tantamount to signing the death certificate of the infant. I would reiterate that anything that can be done to support breastfeeding is desirable (Latham 1963).

When this was written, only a tiny minority of infants in the USA was ever breastfed, and breastfeeding was declining worldwide. Michael then was working in Tanganyika (now Tanzania) as director of the Nutrition Unit of the Ministry of Health. He was among very few professionals who recognized this problem. Others speaking out were Dick and Patrice Jelliffe, then working in neighboring Uganda, and Cicely Williams in Lebanon. After his move to the US, Michael became a prominent figure in the international and US Nestlé boycott. The Nestlé Corporation was the leading exporter of infant formula to non-industrialized countries and spent millions of dollars annually in aggressive marketing, hooking mothers and babies onto artificial feeding. This led to a huge worldwide campaign to boycott all Nestlé products until the company modified its aggressive marketing. In 1978, the National Council of Churches held a large meeting in New York to consider whether the churches should endorse and support the boycott. INFACT, the boycott organizers, chose Michael to be their one permitted spokesman. After his address, Nestlé vice president Ernest Saunders was given equal time to respond. The bishops and Council members then voted overwhelmingly to support the boycott. Michael's presentation *The Case against Nestlé* was later published by INFACT and received wide distribution (Latham 1978).

Between 1968 and the present, Michael and his colleagues, and many graduate students, conducted much research on infant feeding, and published many research and advocacy papers and monographs. This includes a major 5 year USAID funded study on infant feeding beginning in 1980 to investigate the causes and consequences of mother's choices with regard to infant feeding in four large cities of four countries: Nairobi in Kenya, Bangkok in Thailand, Semarang in Indonesia and Bogota in Colombia. This study had three principal investigators: Dr. Beverly Winikoff from the Population Council in NY, Dr. Giorgio Solimano from Columbia University, and Dr. Michael Latham from Cornell University. A broad range of other studies were also conducted, for example by Stina Almroth at different times in Jamaica and Lesotho, by Ted Greiner in St. Vincent and Yemen, by Terry Elliot and Penny van Esterik in Kenya, by Carolyn Campbell in Mexico, by Zeinab Sayed in the Sudan, and by Judy Pojda in Belize.

Between 1975 and 1982, Michael was series Editor of six lengthy Cornell international nutrition monographs on infant feeding, and many members of the Cornell group served as authors. They presented research findings on such topics as the economic value of breastmilk, the influence of breastfeeding on fertility, and the role of Nestlé in the decline of breastfeeding. Over all these years, Michael has continued to be a strong advocate for breastfeeding and has worked to reduce what he sees as the unethical promotion of breastmilk substitutes. Michael also played a significant role in the development of the International Code of Marketing of Breast-milk Substitutes (the Code, often termed the “WHO Code”); he took a leading role in the founding of the World Alliance for Breastfeeding Action (WABA), now being Co-Chair of their International Advisory Council, and has written extensively on infants’ breastfeeding rights. In recent years he has been in the forefront of the debates on optimal feeding for infants born to women positive for HIV. This work included a four country study (Kenya, Botswana, Uganda and Namibia) for UNICEF, conducted with Pauline Kisanga of IBFAN (Africa), to determine the impact of the HIV/AIDS pandemic on breastfeeding in Sub-Saharan Africa (Latham and Kisanga 2001)

The case against Nestlé

Below are some paragraphs from Michael’s 1978 presentation to the Governing Board of the National Council of Churches in New York, which led to their support of the Nestlé boycott, and therefore support for breastfeeding. This illustrates Michael’s views.

I feel deeply moved and honored to have the opportunity to talk to the Board of the National Council of Churches today. I am here because I believe from the bottom of my heart that your vote to endorse the Nestlé boycott will contribute meaningfully to saving the lives of young infants from poor families in Africa, Asia, and Latin America. I am a physician, a nutritionist and a scientist, and have thoroughly reviewed the medical literature on breast and bottle-feeding. I am currently involved in research into the issue, and have for over 20 years been writing about it. My interpretation of the scientific evidence leaves absolutely no doubt in my mind first that bottle-feeding is a major cause of morbidity and mortality in developing countries and secondly that the promotion of formulas by Corporations such as Nestlé’s has contributed significantly to this most tragic of problems... (Latham 1978).

He went on to say:

I lived for 9 years in East Africa working in small hospitals, and in large ones, in Tanzania where I directed the Nutrition Unit of the Ministry of Health. I continue to be involved in programs and research in third world countries. Currently I direct large research projects both in Kenya and in the Philippines. In all of the many developing countries where I have worked, bottle-feeding is killing babies. When I see an emaciated, dehydrated, seriously ill baby, and I learn from the mother that he has been bottle-fed and that she could have breast fed that baby, I do become emotional. When I find that the mother was persuaded to bottle-feed rather than breast feed because of the immoral promotion of infant formula then I do become angry. I wonder how our countries, generous Christian countries, like the United States and Britain and Switzerland can allow this to happen. Yet it is our major food corporations who are responsible. These are respectable corporations whose directors attend our churches, ones in which we as individuals and institutions invest,

and businesses which most of you support with your dollars when you purchase their products.

I have read the Nestlé view presented to you and I have heard their statements. I find that their argument is clever, yet largely fallacious. Nestlé, like many of the large transnational corporations, can afford millions of dollars to promote their products while appearing to adhere to newly promulgated guidelines and they can spend huge sums fighting the boycott and producing evidence for you. In contrast I, and other concerned doctors and nutritionists, churchmen and lay workers, get no financial support for our fight to oppose them. All we can do is take a few hours off from our busy schedules to speak out against the actions of the corporations and in favor of our silent constituency, the infants of the poor.

Nestlé states that Infant Mortality Rates have improved in many countries over the last few decades at the same time that bottle-feeding has increased. But to conclude from this that bottle-feeding has caused, or even contributed to, this decline in infant mortality is statistical nonsense. My first lesson in statistics taught me that this kind of inference is completely fallacious. Infant mortality rates in New York City declined markedly between 1940 and 1970 while addiction to heroin increased and while divorce rates rose dramatically. But no one, except apparently a Nestlé's logician, would argue that infant deaths were reduced by heroin or divorce. Clearly, infant mortality rates have dropped because of a host of factors such as improved health care, immunizations, higher standards of living, etc. Nestlé did not show you statistics from, for example, Sweden where breast feeding has dramatically increased and where infant mortality rates are much lower than in the United States. They did not show you figures from China where infant mortality rates have declined and yet breast feeding is the usual means of infant feeding.

Nestlé says that morbidity data are lacking, and implies that there is not good evidence of an increased disease incidence in bottle-fed infants. That is patently untrue. There are dozens of studies, old ones from the first half of this century, and very recent ones, some from western industrialized countries, and others from the third world, that show a much higher disease incidence in bottle-fed than in breast fed infants. No scientist or immunologist can deny the fact that human colostrum and breast milk contain substances which confer immunity on the infant and protect him from infections, and that infant formulas do not contain these substances. A study published last year in the prestigious *Journal of Pediatrics* showed a significantly lower rate of infections in breast than in bottle-fed infants even in the affluence of Cooperstown, New York. The American Academy of Pediatrics, the official US pediatric association, has this year come out with an official statement endorsing breast feeding. This paper states that "Breast feeding is strongly recommended for full term infants" and goes on to say that "ideally breast milk should be practically the only source of nutrients for the first 4 to 6 months for most infants." That is a rather clear, and rather definite statement. It comes from a group of doctors who should know best, and US doctors are not well known for supporting liberal causes.

Nestlé states that "the preponderance of available evidence points to a mother's need, or desire, to work, as the principal reason for breast feeding decline." Our review of studies from third world countries, and our own work, suggest that this is not the case. An analysis of recently published studies from five countries in Asia, Latin America, Africa, and the Caribbean suggests that no more than 6 % of mothers in any country said that they gave up breast feeding in order to work. Certainly in

most western countries it is often made difficult for women to hold paid employment while continuing to breast feed. But countries such as Sweden and China make it quite easy for mothers both to work and to nurse their infants.

There are many factors which influence mothers in developing countries to bottle-feed rather than breast feed their infants. These include a lack of encouragement by health professionals, the fact that the breast has become a sex symbol and the belief that breast feeding may alter the contour of the breast, and the false impression that breast feeding is primitive and bottle-feeding is sophisticated. But the main reason that women in developing countries bottle-feed is that they falsely believe that it is better for their infants. This belief has come largely from the promotional practices of the corporations who market infant formulas.

Nestlé and the other major corporations have been aggressive in their promotional campaigns. This promotion in my view has been unethical and immoral. It helps persuade mothers to do something that may be harmful to their infants and may even be lethal. Large sums of money have been spent on promotion to the public and to physicians (Latham 1978).

The International Code of Marketing of Breast-milk Substitutes

From 1963, until the Code was finally adopted by the World Health Assembly almost two decades later, Michael was a leader among professionals in the long, and often divisive, battle to control the very harmful promotion and greater use of breastmilk substitutes, which resulted in major declines in breastfeeding in many non-industrialized countries. He was an important figure at the conference held at WHO headquarters in Geneva in 1979, where advocates for control of advertising and promotion of infant formula won over opponents of a code—a strong group of manufacturers assisted by many prominent pediatricians and nutritionists. Some of these health professionals, regrettably, received financial support from industries which manufactured infant formula.

In May 1981, the World Health Assembly (which is like the Parliament for WHO member states) overwhelmingly endorsed the International Code of Marketing of Breast-milk Substitutes. The USA was the only country to cast a negative vote, and did this against the advice of most health professionals including pediatricians. Following the vote in Geneva, the US Senate, under the auspices of Senator Edward Kennedy, held hearings on the Code and the US stance on it. Michael was one of four “experts” testifying at the opening day of these hearings. Shortly thereafter, both the US Senate and the House of Representatives quickly passed resolutions disavowing the negative vote cast by the US Executive Branch under President Ronald Reagan at the World Health Assembly (Latham 1982a)

There were many reasons why Michael and his colleagues had battled for, and then supported, the Code. Approximately 100 million babies are born in the world each year in developing countries. Some 15 million of these will die in the first few years of life. Among the major causes of death are diarrhea, respiratory disease, and other infections. Many of these deaths are associated with malnutrition. The role of inappropriate infant feeding, particularly the use of infant formula and bottle-feeding, had been clearly shown to be a major contributory factor in morbidity and mortality of infants.

As early as 1963, while working in Tanzania, Michael had drawn attention to the problems of “bottle-feeding,” of the “aggressive promotion of infant formula” in poor countries, and their health consequences, writing of a

...new and serious problem which has been introduced into Tanganyika from the civilized world is that of pernicious advertising. The worst example of this advertising is the picture of a contented well-dressed mother bottle-feeding her plump healthy baby, using some proprietary milk preparation. The implication is, of course, that it is simple and more sophisticated and in some ways better to bottle-feed rather than breastfeed. There is no truth in it in any society (Latham 1963).

Breastfeeding and fertility

For many years, Michael was a member of the Committee on International Nutrition Programs of the United States National Academy of Sciences/National Research Council (NAS/NRC). That committee became interested in an exploration of the relationships between nutrition and fertility in the early 1970s, when there was a major focus on world population increases and birth control measures. A small NAS/NRC subcommittee on nutrition and fertility was appointed. As a member of that subcommittee, Michael did research and wrote a report entitled *The effects of lactation on human fertility*. He used that report for a longer article entitled *The relationship of breastfeeding to human fertility* (Latham 1982b) which begins as follows:

For a very long time the traditional wisdom of many societies included a belief that lactation prevented or reduced the risk of pregnancy. Because every student of the subject could point to women who had become pregnant during the time they were still breastfeeding their infants, the belief tended to become relegated to that of an old wives tale. Scientific evidence now proves beyond question a positive relationship between lactation and length of post-partum amenorrhea, anovulation and reduced fertility. It also supports the view that breastfeeding is not a sure and safe prophylactic against pregnancy.

Despite these accepted facts there is much that is both misunderstood and not fully known concerning the impact of lactation on human fertility. It is also evident that existing knowledge has been insufficiently used either by nutritionists or family planners to further their own goals.

The physiological mechanisms by which human lactation influences ovulation and menstruation are not yet fully understood. It is now believed that nipple stimulation, mainly through sucking of the infant on the human breast, results in hypothalamic suppression of the prolactin inhibiting factor. Sucking therefore influences the anterior pituitary gland to release prolactin. This hormone stimulates milk synthesis and secretion, and also represses ovarian activity.

It appears that the frequency, intensity and duration of suckling are probably the most important determinants of the length of post-partum amenorrhea and on the time when ovulation returns in mothers, following the birth of an infant. Therefore, in women exposed to sexual intercourse, all other things being equal, the most important physiological factor influencing the spacing of births appears to be breastfeeding, and especially its frequency, intensity and duration.

It is well established that lactation is dependent on two hormones, namely oxytocin and prolactin. Oxytocin is responsible for the let down reflex in breastfeeding and has an effect on the uterus, but it does not appear to play a major role in fertility. On the other hand, prolactin is the hormone which controls milk production. The pregnant woman has high levels of prolactin even though she is not lactating. But it is believed that the high levels of estrogen present during pregnancy inhibit milk production. Soon after birth there is a drop in the mother's estrogen levels, while prolactin levels remain high, and often rise. If the mother breastfeeds her baby, then nipple stimulation will result in the maintenance of high prolactin levels.

In the presence of continued nipple stimulation resulting from frequent and intense breastfeeding, prolactin levels remain high, but over a period of many months levels do gradually drop. These high or relatively high levels of prolactin are generally believed to maintain lactational amenorrhea. For each mother, as prolactin levels gradually fall, there is probably a trigger level reached, where menstruation resumes. But this is many months after delivery, provided that adequate stimulation is provided to the nipples.

The data from the studies relating lactation to pregnancy intervals provide strong evidence that the intensity of lactation is a factor. It seems that a mother who is breastfeeding her baby frequently, who is having her breasts fully emptied, and who is subjected to a considerable amount of nipple stimulation through sucking, is likely to have a longer post-partum interval of anovulation than is the woman who breastfeeds her child irregularly and for shorter periods of time. Future research needs to divide women according to intensity as well as duration of lactation (Latham 1982b).

A few years later, the research in Kenya and Indonesia provided data from 981 mother-child pairs in the city of Nairobi, Kenya and 1,092 in Semarang, Indonesia, to examine the apparent relationships between both, duration and likely intensity of breastfeeding, on amenorrhea (Latham, Winikoff, Solimano and Laukaran 1986). In both cities there was a long duration of breastfeeding with a median length in Nairobi of 16 months and in Semarang of 22 months. Median amenorrhea in Nairobi was 7 months and in Semarang 10 months. In Nairobi, compared with Semarang, there was a much greater use of breastmilk substitutes, mainly infant formula and cow's milk from a feeding bottle (45 vs 23 % at 0-4 months and 58 vs 18 % at 5-9 months of age). In both cities, solid foods were commonly introduced early. The amounts fed were believed to be relatively small up to 6 months of age, and then become an increasingly important contribution to the young child's diet. In Nairobi, 38 % of infants between 1 and 2 months of age were already receiving breastmilk substitutes; these infants were from the lower socioeconomic classes. In both cities, the median length or duration of breastfeeding was considerably longer in those not using, compared with those using, commercial milk. So, feeding commercial milk preparations was associated with a markedly shorter length of breastfeeding.

Data on the frequency of breastfeeding in the last 24 hours showed more frequent breastfeeding in Semarang than in Nairobi. There was a marked decline in daily breastfeeding frequency as the child grew older in Nairobi, but this phenomenon was not observed in Semarang. The difference in frequency of breastfeeding in the two countries was almost certainly due to the much higher prevalence of bottle-feeding in Nairobi.

A number of studies have found correlations between, on the one hand, duration of breastfeeding and amenorrhea, and on the other, factors such as mother's age, parity, educational level and economic status. We also found that all four of these were related to breastfeeding duration and length of amenorrhea in the expected direction. The data were further examined using both a multivariate and a hazards analysis. After accounting for the effects of breastfeeding, socioeconomic variables remained as significant covariates. For example, women with more schooling still seemed to have a shorter duration of amenorrhea. Despite this, we believe that breastfeeding and the pattern of other feeding were the most important determinants of length of amenorrhea in these women.

Among the women we interviewed, 23 % in Nairobi and 24 % in Semarang reported using contraceptives at the 6th month postpartum. However, at the 12th month, the figures were 12 and 48 % respectively. The World Bank reports that only 7 % of women 15-49 years of age in Kenya and 26 % in Indonesia used contraceptives. The annual population increase was projected at 4.1 % in Kenya and 1.5 % in Indonesia. The paper concludes:

We believe that in both countries breastfeeding is playing an important role in influencing birth-spacing. In Indonesia the duration of breastfeeding is longer, frequency of suckling is higher, and there is a lower use of breastmilk substitutes than in Kenya. This, together with greater use of contraceptives, reduces fertility.

Using the WHO typology of breastfeeding, Kenya, like Indonesia, would be placed in the 'traditional phase with high prevalence and duration of breastfeeding'. But our data show that even though breastfeeding prevalence and duration are high, there is a pattern of triple nipple infant-feeding. In the first few months of life a majority of Nairobi babies are fed breastmilk substitutes often from a bottle, there is a declining frequency of breastfeeding, and as a result amenorrhea is reduced in length and birth intervals may be markedly shortened.

It is postulated that when more than about 750 ml of breastmilk is being consumed in the first 18 months, then prolactin levels remain high enough to maintain amenorrhea. This level of milk would provide about 2.3 MJ (550 kcal), 100 % of energy needs for infants at 2 months; 62 % for infants at 6 months; 53 % for infants at 12 months; and 49 % for infants at 18 months of age.

The contrast between Semarang and Nairobi is strikingly revealed in this study. National differences in breastfeeding duration (22 vs 16 months), birth intervals (36 vs 29 months), and contraceptive use (33 % vs 7 % in 2nd year postpartum) were also shown in the World Fertility Study.

We conclude that the pattern of infant feeding is having an important influence on fertility in Nairobi, and probably elsewhere in Kenya. If this pattern of infant feeding persists or becomes more extensive, then Kenya's fertility can be expected to increase above its currently alarmingly high levels. We believe that in both countries great efforts are needed to protect, support and promote breastfeeding. Such actions if successful will have important effects on child spacing and at relatively low cost. They need to be regarded as the partner of each country's programmes to control family size using modern contraceptive methods (Latham, Winikoff, Solimano and Laukaran 1986).

Breastfeeding in four countries – research on determinants of infant feeding practices in Kenya, Colombia, Thailand and Indonesia

Michael, together with Dr. Beverly Winikoff of the Population Council and Dr. Georgio Solimano from Columbia University, served as Co-Principal Investigators for the first large USAID supported breastfeeding study. It began in 1980 with the objective of investigating the determinants of infant feeding practices in four very different large cities in developing countries: Nairobi in Kenya, Semarang in Indonesia, Bangkok in Thailand and Bogotá in Colombia. The study specifically focused on the role of health care systems, infant food marketing and distribution strategies, women's labor force participation, and the nature and magnitude of their contributions to infant feeding patterns. Information was also collected on a broad range of biological, cultural, social, and economic factors.

It was recognized that breastfeeding had declined in many developing countries. The increased awareness of the importance of appropriate nutrition for child survival led to an interest in gaining a better knowledge of the factors that influence feeding patterns under different social and economic conditions. This could guide the development and improvement of nutrition policies and programs to create circumstances more favorable to breastfeeding. Because of the increasing number of alternatives for infant feeding available in modernizing societies, mothers need culturally appropriate information to enable them to make better feeding choices. Clearer understanding of the forces that influence mothers could help to design such information.

In each city, studies were undertaken, in collaboration with local investigators. Interdisciplinary research teams were formed to address each of three selected study components. The first component was ethnographic field work, consisting of participant observation of infant feeding practices in the home and similar observations in health service settings. A second component was a cross-sectional household survey of mothers of infants, focused on infant feeding practices and their determinants. Finally, a market research component on the infant food market for each country included the analysis of the development and state of the infant food industry and the structure of the market. As part of the market research, a cross-sectional survey in each site included a module of questions designed to provide data on consumer behavior with regard to acquisition and use of infant food products. In each site, the study components were timed to ensure that the first phase, the ethnographic field work, could be used as a basis for the development of the survey questionnaire for mothers and the research design for studies of the infant formula market. Dr. Penny Van Esterik, an anthropologist then based with Michael Latham at Cornell University, was the leader for the important ethnographic component.

Michael was the Principal Investigator who took greater charge of the studies in Kenya and Indonesia. Dr. Georgio Solimano did this for Colombia and Dr Beverly Winikoff for Thailand. All three PIs were involved in the overall research. Here, summaries of the findings as well as recommendations are briefly described for each of the four countries, with somewhat more detail about the findings in Nairobi and Semarang.

Research on determinants of infant feeding practices in Nairobi, Kenya

Other Cornell professionals involved in this study included Dr. Lani Stephenson, Terry Elliott, Dr. Ted Greiner and Dr. Penny Van Esterik. The results are consistent with those of other surveys of Kenyan mothers in terms of the demographic profiles, living conditions, and infant feeding practices uncovered (Winikoff, Latham and Solimano 1986d).

Forty-nine percent of the index children were female, 51 % male. The ages were distributed fairly evenly over the range of 0 to 18 months. Sixty-five percent were born in government clinics or hospitals, 12 % in private hospitals or clinics, and 23 % at home. Seventeen percent had been hospitalized overnight for an illness since birth and 44 % were reported to have been ill in the last 2 weeks. Ninety-seven percent had at some time been breastfed and 77 % were breastfeeding at the time of the interview. The feeding pattern most often observed was breastfeeding with the early introduction of either cow's milk/infant formula or solid and semi-solid foods. Seventy-five of the 97 % who initiated breastfeeding started within the first 24 hours after birth. Most mothers breastfed for a long period of time with 85 % reporting breastfeeding at least once a day at 6 months and more than 50 % still breastfeeding at least once a day at 15 months. Infant formula use at some point in time was reported for more than half of the index children. Formula use seemed to peak at about 3 months and then decreased. This pattern contrasted with the use of cow's milk, which became part of the child's regular diet as he grew. Most of the index children were receiving food supplements in all age categories 4 months of age or older. The median duration of breastfeeding was calculated to be slightly over 16 months. Twenty-four hour recall data confirmed the information collected on feeding patterns and reflected the common use of glucose drinks also reported by the ethnographers.

Problems of maternal morbidity associated with breastfeeding were not common in the sample, with only 11 % of the mothers reporting any problem. Engorged breasts were most often reported, followed by sore nipples and infections. Survey data showed 18 % of the women had used a modern birth control method since the birth of the index child with 12 % using oral contraceptive agents and another 4 % reporting use of an IUD.

Mothers strongly believed that they should not breastfeed while pregnant and that infant formula, in addition to breastfeeding in the first 3 months, would make a baby healthier. Most understood the contraceptive effect of breastfeeding and had mixed feelings about the appropriateness of breastfeeding in public. Knowledge and attitudes seemed to be associated slightly with education but not much with length of time in Nairobi, age, or tribe.

Proxy factors were developed from the survey data to represent family socioeconomic status. These were then used as independent variables to look at both feeding practices (use of infant formula and packaged cereal, and duration of breastfeeding) and outcome variables (reported illness in the previous 2 weeks and weight-for-age). The use of infant formula or packaged cereal increased with household head's occupational status, mother's education, housing quality and decreased household density. Duration of breastfeeding was lowest for the best educated mothers and those with best housing quality. The lowest reported morbidity was for children whose mothers were in the highest and lowest education groups and for those with the most improved housing. The latter was also positively associated with weight-for-age.

More mothers of infants born in hospitals/clinics later fed formula than mothers giving birth at home. One-third of the mothers receiving prenatal feeding advice, and three-fourths of those receiving feeding advice at delivery, either recalled being given misinformed advice or could not remember what they were told. A significantly greater number of children delivered by modern health workers were found to have been given infant formula or infant formula/cow's milk in their first 4 months of life.

Only 11 % of the women interviewed were working outside the home, and half of those were usually able to see their child during the work day. Working away from home did not appear as a constraint to breastfeeding for most mothers. Using 24 hour dietary recall data, and controlling for child's age, there were, however, significant differences in the diets of children whose mothers worked outside of the home and those who did not. Significantly more children whose mothers worked outside of the home consumed infant formula, *uji* with milk, commercial cereals, protein rich foods, vegetables, and fruits. Significantly more children of mothers either not employed or working at home, received breastmilk in the previous 24 hours, and their median duration of breastfeeding was longer than for children whose mothers worked outside the home (16.23 vs 12.04 months).

Most mothers using cow's milk used KCC or fresh, unprocessed milk. Of those using formula, about 85 % used one of the food specialties products (Nestlé's Nan or Lactogen). Ninety-six percent of mothers who used commercial cereal used the food specialties product, Cerelac. Most mothers used the same brand most of the time for formula or cereal and said they chose it because of price, availability, or because "it is best for the baby." The cost of exclusively feeding formula to a baby for 6 months was, depending on brand, between 36 and 64 % of the 1982 minimum wage. Many mothers recalled past infant formula advertising even though it had been stopped for 4-5 years.

Children of "urban" mothers were only about one-third as likely to breastfeed for 9 or 12 months. Being born in a hospital reduced the odds of being breastfed 6 or 9 months to less than half those of non-hospital born children. Higher maternal education also reduced the odds of breastfeeding for at least 6 months, but the magnitude of the effect was not as large. Early use of a bottle was associated with higher family economic status. That alone emerged as a significant determinant of this outcome, although it appeared unrelated to duration of breastfeeding. A child from higher income families was almost one and one-half times as likely to be introduced to bottle-feeding by the second month of age.

Most of the associations in these models highlight factors which depress breastfeeding duration. Higher education of the mother had a weaker relationship than the other three variables identified: urban mother, hospital birth, and early use of bottles. Identifying these factors as predisposing towards shorter breastfeeding suggest that this pattern may become more common as trends toward urbanization and improved access to health facilities continue. On the other hand, it is reassuring that higher family socioeconomic status did not seem independently to predict shorter breastfeeding and that the effect of higher education was only marginal.

It was important to identify early bottle-feeding and hospital births as determinants of infant feeding behavior in Nairobi since both may be subject to modification. It also suggests

that if practices and procedures in hospitals were modified, this may translate into less ambivalent messages about breastfeeding and less mixed feeding early in life.

The only variable that appeared related to early bottle-feeding was higher socioeconomic status. Working outside the home did not appear to predispose mothers to bottle-feed, nor did higher maternal education. Since early bottle-feeding was associated with higher income families who were generally accessible to educational messages *via* all media, the health consequences of this practice could potentially be the subject of educational campaigns. As in the US and Western Europe, higher income families may, in fact, be amenable to changing their infant feeding practices once the benefits of breastfeeding are made explicit and widely known.

Because it is widely recognized by physicians, research scientists, and manufacturers of breastmilk substitutes, that exclusive breastfeeding provides the best possible diet for an infant for the first 4-6 months of life, all policies that foster this practice will also promote optimal infant nutrition. Continued breastfeeding after 4-6 months, supplemented by semi-solids and solid foods, is the best regimen for children in the period following exclusive breastfeeding. Policy based on these results should thus reflect the need to decrease the amount of early supplementation of breastfeeding: almost all Nairobi mothers breastfed and almost all did so for substantial periods of time. The most striking deficit in feeding patterns was the extent to which early breastfeeding was supplemented – both with food and with other milk.

In a 1982 paper, Greiner divided breastfeeding policy into three categories of activities: (1) protection of breastfeeding, (2) support of breastfeeding, and (3) promotion of breastfeeding (Greiner 1982). Protection of breastfeeding refers to activities which guard women already breastfeeding from forces which would influence them to do otherwise; support of breastfeeding refers to providing assistance to women who are motivated to breastfeed but who find themselves facing conditions which make this difficult; and promotion of breastfeeding refers to convincing women who are not motivated to breastfeed, that they should do so. While all three categories of activity are important, Greiner argues forcefully that priority needs to be given to protection, then support and finally to promotion. An analysis of how the Nairobi situation fits these three policy categories follows.

Protection of breastfeeding

Data from both the cross-sectional survey and the ethnography clearly show that the Nairobi women are successful, enthusiastic, and well-motivated breastfeeders (Winikoff, Latham and Solimano 1986d). Of the policy categories described above, protection of breastfeeding is thus the most important for Kenya.

Since any feeding pattern that interferes, or competes, with breastfeeding gives an infant less than optimal nutrition, it is these patterns that need to be avoided. The promotion and availability of breastmilk substitutes thus need to be examined. Cow's milk and infant formula must be treated separately because in Kenya their promotion, availability, and use, were not the same. The promotion of infant formula had moved from the mass media advertising of the previous decade, to more subtle promotion through health care facilities. This included free supplies to institutions, posters, booklets, hospital visits by "milk nurses,"

and in some cases, free samples to mothers at delivery. Legislative enactment of the provisions of the *International Code of Marketing of Breast-milk Substitutes*, which the government had supported in Geneva in 1981, would go far to curb such practices. The cow's milk products that are labeled as breastmilk substitutes constitute a tiny fraction of the Kenyan market and their promotion would also be covered under the Code.

Both the marketing and cross-sectional data showed infant formula to be widely available to even the poorest and least educated mothers in Nairobi and that these products were marketed not only to those who could afford them and had the education and facilities to use them safely. Infant formula use was reported by over half of the women interviewed in the cross-sectional survey. It was mainly used as a supplement to breastmilk, and very few women formula fed exclusively.

Support of breastfeeding

Two potential obstacles to successful breastfeeding are employment outside of the home (where the mother is physically separated from her child) and maternal breast morbidity, or other problems with breastfeeding itself.

Maternal employment outside the home was not important as only around 6 % of the women studied were employed in circumstances where they did not usually have contact with their child during their work. In addition, Kenya's 2 month maternity leave policy helped ease this constraint and the policy in some agencies of allowing annual leave to be added to the maternity leave period helped even more. This should be supported, as well as innovative policies related to on-site day care facilities where mothers can breastfeed during breaks and at lunch, job sharing, and extended unpaid leave.

Support to mothers with problems should also be made available through health personnel and facilities, as well as women's groups and organizations like the Breastfeeding Information Group, which provided counseling for breastfeeding mothers as well as other educational inputs.

Promotion of breastfeeding

Eighty-five percent of the women sampled expressed the view that babies are healthier if given infant formula in the first 4 months of life. This indicated the need to re-educate women to the economic, health and other benefits of exclusive breastfeeding for the first 6 months of life (Winikoff, Latham and Solimano 1986d).

Research on determinants of infant feeding practices in Bogotá, Colombia

This examination of everyday life of low income, young families in Bogotá, Colombia, demonstrated that the infants from these families often appeared to be fed insufficient quantities of bottle milks, strongly diluted with *panela* water and starch, rather than exclusively receiving their mother's breastmilk. In many ways, the difficulties of feeding infants for the women in this sample were an integral part of the crises of life in poverty. Un- and under-employment, substandard housing and sanitary facilities, and related problems these women faced, emphasize the fact that infant feeding choices and maternal behavior in Bogotá were part and parcel of the ongoing process of economic and social change in Colombia (Winikoff, Latham and Solimano 1986c).

Although the belief that bottle milks are superior nutritionally had clearly penetrated Bogotá households, their use in a mixed feeding regime (the predominant infant feeding pattern) could only be partially explained by this notion. The study identified many women with knowledge of appropriate infant weaning foods, who believed breastfeeding was superior nutritionally, who nonetheless faced structural and cognitive barriers to implementing such patterns in their own families. Decisions regarding the feeding of children appeared to be also part of a larger tendency to devalue women's social roles. In many instances, the common practice of weaning onto bottle formulas appeared to be associated with the appropriation of infant feeding decisions by others, both family members and health professionals. In one sense, women appeared to be internalizing the judgment of males who perceived breastmilk as inferior to bottle milk.

The "insufficient milk syndrome" was thus part of a complex change in women's status. The syndrome was inextricably related to the utilization of hot and cold classifications of behavior and foods, as well as to the exertion of social control over women. The consequence can be lactation failure or unnecessary supplementation, which often lead to premature weaning. Perceptions of insufficient milk exist among new mothers worldwide; however, it is necessary to understand its cultural context in order to formulate approaches to the problem in particular nations.

The typical Bogotá household consisted of 4-5 people living on a median aggregate monthly income of 10,000 pesos (US \$185 at the time of the study). Obviously, disposable income was much lower. Fifty-four percent of the households lived on less than 5,000 pesos per month after food expenditures were deducted. Although the majority reported access to electricity (97 %), to running water (96 %) and to a toilet (92 %), these figures are compromised by the fact that almost half of the families lived in boarding house-type dwellings and shared both toilets and running water with other families. In situations where water facilities must be shared, one cannot be assured that families had a constant supply of clean water. At least 20 % stated that they stored water in buckets, pots, pails, large cans or drums - containers that are easily contaminated. Finally, 5 % had no facilities whatsoever and less than one-third owned a refrigerator.

Sample mothers were young, 61 % between the ages of 20-29 years with a median of 24. More than half had completed less than 8 years of education. Two-thirds were migrants and 36 % were Bogotá-born. Over 80 % had three children or less, and one quarter worked at outside jobs as well as having household responsibilities.

The median age of the index children was 5 months, with fairly equal numbers of boys and girls distributed over the first months of life. Almost 90 % were born in a hospital, the rest in a midwife's house or their own home. Most (97 %) had been breastfed at some time during their life. Forty-six percent were exclusively breastfed in the first month, with precipitous declines to 10 % and 3 % at the second and third months as food and breastmilk substitutes were added to the diets. Thus, the predominant feeding regime beyond the second month in Bogotá was a reliance on a mixed pattern of breastmilk, supplementary foods and milk substitutes. This mixed pattern did not appear to be new, although the use of formula supplements was. At 4 months, 100 % received food supplements in combination with milk. As breastfeeding declined, non-human milk and food became the typical choice and steadily increased. The median duration of breastfeeding was 6-9 months.

The mean daily frequency of breastfeeding decreased from 8 per day at birth, to 6 at 1 month, and 4 at 6 months. This indicates the steadily increasing importance of breastmilk substitutes and foods throughout infancy, even among those who continued to breastfeed. Length and frequency of lactation have been associated with amenorrhea and, hence, natural contraception. As expected, the proportion of amenorrheic women was higher in the group with a higher frequency of breastfeeding. This suggests that women who wish to better space their pregnancies should be encouraged to exclusively breastfeed for longer durations.

There appeared to be differential feeding patterns between boy and girl infants. This may reflect a varying response of the mother to breastfeeding difficulties depending on the sex of the child, as well as differential pressure by fathers to cease breastfeeding and introduce bottles for boy babies. It may also have been associated with the larger question of “insufficient milk” and the appropriation of control over feeding of children by men. Other studies have indicated that, in some cultures, fathers are jealous of the emotional and physical relationship between boy infants and their breastfeeding mothers.

Almost 60 % of the mothers of weaned children stated they weaned because of an inadequate milk supply. Very few women suggested that increasing the frequency of breastfeeding might increase milk supply. Fifteen percent of those with insufficient milk stated their milk dried up because of sun or heat, a belief arising from the hot-cold classification system. Poor women stated that they were living and working under more difficult conditions than in the past, *i.e.*, as compared with their mothers or when they lived elsewhere. They claimed that lower and unstable incomes led to poor nourishment and health in their children who were born in Bogotá. Grandmothers corroborated this, saying that their own children ate a better and wider variety of foods, were breastfed for longer durations, and were thus healthier than their grandchildren born and raised in Bogotá.

The combined pressure of men who suggested that women stop breastfeeding and of the availability of bottle milks (at local drug stores where credit was extended, at health clinics and hospitals, and through governmental supplemental programs like PAN) contributed to the introduction of bottle formulas and the early cessation of breastfeeding. This was a powerful cumulative set of influences, especially for women who could not participate in postbirth rituals which would validate their role as mothers and provide some communal respect.

Use of bottle milks was related to early weaning, and 30 % of the women fed it to their infants immediately before or after breastfeeding. This pattern can condition an infant to expect bottle milk, causing a reduction in breastfeeding and, in fact, in milk supply. Weaning would follow, whether consciously or not. On the average, weaning took place less than 2 months after the bottle was introduced. According to the grandmothers interviewed, weaning of their own children consisted of introducing appropriate amounts and mixtures of local foods, including grains, vegetables, and fruits, in liquid or soup form. Thus, mixed feeding using breastmilk and foods seemed to be a well-established pattern among Colombian mothers. Use of foods was more common than the bottle at all ages, except in the first and second months. At 7 months, children were expected to eat “anything”.

Dilution of milk was an important issue and fell into three major categories: 1) liquids - sugar water, herb or vegetable water; 2) more water than advised; 3) replacement of part of

the powdered milk with flours or cornstarch. Such additives can compromise the nutrition of bottle-fed children. According to pharmacists interviewed in several sectors, dilution was a widespread cause of malnutrition. Closely associated with dilution of milk, was the reported lack of cleanliness of bottles. A quarter of the mothers indicated they washed out their baby's bottle only once or twice a day. Methods varied and included boiled water, no soap, and rinsing in any available water. The use of *panela* water in milk undoubtedly made the milk much sweeter than breastmilk. It may also lead to severe dental caries, a common problem in exclusive bottle-feeding cultures.

There were high levels of adulteration, toxicity and contamination in *panela*, which was produced using toxic chemicals with no quality control. Although *panela* use was high and clearly culturally preferred, the widespread knowledge of a whole range of infant foods indicated that women were aware of their superior nutritional qualities. Enabling women to increase the purchase of good food might decrease their use of *panela* which is cheap. Its level of use appeared closely linked to cost and availability.

Of the women who never initiated breastfeeding in this study, it was clear that mothers of low birth weight and premature infants needed encouragement in the hospitals to breastfeed (or express milk until they could).

Breastfeeding duration was associated to varying degrees with mother's age, education, parity and family income. Higher family income was associated with shorter duration of breastfeeding. In addition to being better able to afford proper use of bottle milks, higher income women had more access to postnatal hospital care, health clinics and private physicians, who may have been a major influence in the decision to wean.

Introduction of a bottle by 1 month clearly was associated with lower odds of breastfeeding to 3 or 6 months. Older women were at greater risk of introducing an early bottle, whereas mothers with more years of education and higher parity were less likely to do so. The negative relationship between education and introduction of a bottle was interesting and in contrast to findings in other developing countries. It may have reflected a high level of concern about nutrition in Colombia in those years, or the extent to which educated women were influenced by trends in Western Europe and North America.

Finally, early bottle-feeding had the consistent, and fairly uniform, effect of lowering the proportion of children in different age cohorts who were breastfed. Introducing a bottle by 1 month was a powerful predictor of the chances of not breastfeeding to 3 months, but there is no way to separate those mothers for whom the bottle represents an intent to wean from those for whom it is associated with unintended termination of breastfeeding.

The marketing component of this study revealed that commercial infant foods were widely available in Bogotá. These included infant formulas produced by multinational companies and infant foods produced locally. The retail audit also revealed that some locally produced products were of low quality and showed evidence of mislabeling, including labels in English, misstatements of nutritional value, and misrepresentation of the product's suitability as an infant food. Some products, not intended by their manufacturers as infant foods, were sometimes promoted as such by retailers. Mass-market advertising was not observed, in keeping with the recent Code restrictions, although around half of the mothers

recalled advertising of infant formulas. Promotional activities now focused on hospitals and health professionals. The distribution of free samples of infant formula was not widespread (6.2 %), but some 25 % of mothers currently bottle-feeding reported that they were using the brand their physician endorsed. Interviews with health care workers also indicated that brand endorsement was routine and had a high probability of establishing brand loyalty.

Only 25 % of the women were engaged in income generating activities at the time of the survey, whereas 36 % had worked prenatally. The working mothers were young (20-34 years) and of low parity (50 % had 1 child). Few mothers with newborns returned to work immediately after the birth of their child. Not until 2 months did the prevalence rise to 15 % and to the mid-20 % at 3 months. This corresponded to the length of maternity leave.

Most working women were away from home 8 or more hours per day and 85 % did not take their children to work with them. The largest occupational category was domestic workers, followed by factory workers, and teachers. Only the last two groups were covered by labor regulations allowing for paid maternity leave and breastfeeding breaks. However, most women who worked seemed to be employed far enough from their home so that they could not take advantage of the breastfeeding breaks mandated by law.

Maternal work did impact on the duration of breastfeeding. The median duration was longer for unemployed women. There was no evidence that work alone was related to the introduction of bottles by 2 months, but working women with children 6 months or younger were more likely to have introduced bottles in a mixed feeding regimen.

Although most women received some form of prenatal care, many were not seen by a health worker until after 6 months of pregnancy. Ninety percent of the births were in hospitals. The survey data showed that, during a prenatal visit, public health sector professionals were more likely to recommend the use of bottle milks than workers in other health facilities. Postnatally, private physicians appeared to recommend the use of artificial milks to a much greater extent than they did during prenatal visits. The medical profession seemed uninformed about the benefits of breastfeeding ill children, about the efficacious methods of increasing mothers' milk supply, and that cessation of breastfeeding for women with mild illnesses was not necessary. The negative recommendations of physicians introduced the belief that breastmilk could be harmful and that bottle varieties were superior. Cumulatively, such advice can diminish confidence in maternal abilities.

Midwives and some of the grandmothers interviewed appeared much more positive about breastfeeding than physicians. Additionally, hospital policies regarding sleeping arrangements of newborns and their mothers were associated with breastfeeding duration and with the early introduction of bottle formulas. Non-working women who roomed-in with their infants at birth had higher odds of breastfeeding to 3 and 6 months than their counterparts whose infants were kept in nurseries. The ethnographers attributed early introduction of milk complements largely to the influence of the professional health sector.

Children of working women were clearly at risk for early cessation of breastfeeding. Some mothers appeared caught in a vicious cycle where they earned income at the expense of leaving their children too early in life, and in turn, spent that income on bottle milk for feedings. The burden of infant care for these women could be lessened considerably by

providing superior nurseries located close to, or at, the work site, higher minimum wages for all workers, including those in the informal economy, and longer maternity leaves. Women (and men) from poor and low-income households need opportunities to gain advanced skills for better jobs. Training, or educational programs, should have a childcare component built into them to be accessible for women with small children.

Many mothers of young children work in order to secure additional resources. By so doing, they hope to better participate in food allotment decisions for themselves and their families. One possible social welfare benefit, therefore, would be for poor and low income women to receive state supported supplementary income, not redeemable for bottle formulas, but designated for culturally recognized nutritious foods for all family members. Any income/food program should be combined with a health education campaign. Fathers need to be included in any health education campaign. A very specific educational program for health professionals is important to inform them about the health, economic, fertility and other serious disadvantages of formula feeding.

Finally, the study findings in Bogotá demonstrated an internal consistency providing justification for an integrated approach to improve maternal and child health, and the detailed results on the social life of women with infants, highlighted the gravity of their situation (Winikoff, Latham and Solimano 1986c).

Research on determinants of infant feeding practices in Bangkok, Thailand

One of the distinctive features in Bangkok, was the high rate of initiation of breastfeeding despite the rapid modernization and shifts in lifestyle of the previous decades (Winikoff, Latham and Solimano 1986b). Only 10 % of mothers reported that their child was never breastfed. Older mothers and mothers born in Bangkok were less likely to initiate breastfeeding. Bangkok born mothers were also likely to stop breastfeeding earlier, as were mothers from higher income families, and those of lower parity. Maternal education was not independently related to breastfeeding initiation or duration. The median duration was just over 6 months.

Exclusive breastfeeding was widespread during the first month and declined rapidly afterwards. Breastmilk substitutes were introduced early, most children receiving some form of supplementation by the fourth month. Food supplements were introduced even earlier, almost all children receiving foods by 3 months. The most common infant feeding patterns were breastmilk and foods, or other milks and foods. Combined breast and bottle-feeding was relatively uncommon and, when it did occur, it appeared to be only of short duration.

The different infant feeding patterns had different significance for the duration of breastfeeding. Children who received other foods while breastfeeding, but no bottle-feeding, tended to exhibit longer breastfeeding duration. Those who mixed breastfeeding and bottle-feeding appeared to convert rapidly to exclusive bottle-feeding. In this regard, it is not surprising that early bottle-feeding appeared independently associated with truncated breastfeeding, both in the survey results and in the ethnographic observations.

Initiation of breastfeeding was not a matter of serious concern; the more pressing issue seemed to be its duration and the very early supplementation so often observed.

The marketing of infant foods in Bangkok was both competitive and vibrant, characterized by a large number of outlets, brands, sizes, and promotional activities. Breastmilk substitutes were widely available, particularly infant formula. All retail outlets carried multiple brands, and it accounted for the largest market share. Sixty percent of provision stores carried infant formula. .

Retailers, manufacturers/distributors, and advertising agency personnel displayed a general awareness of government regulations and of the Code, but a limited knowledge of specific regulations regarding the marketing of infant formula. A number of hospitals had retail store operations that sold formula products. These were claimed to be a convenience for the mothers; however, they were also a source of revenue for hospitals and represented a marketing innovation on the part of the formula companies.

Since 1980, there had been a large reduction in mass media promotion of infant foods in Bangkok because of the government ban on advertising of infant formulas. No radio or TV advertisements were observed by the research staff and only occasional print ads were seen. Large numbers of mothers, however, continued to recall mass-market advertising of infant foods, and brand awareness was high.

Maternal income generation, when it took place in the home, did not appear to influence infant feeding behavior. Work outside the home, however, had a very important influence on infant feeding practices for that subgroup of women. Overall, it increased the probability of introducing early bottle-feeding and of decreasing the duration of breastfeeding, though initiation was little affected. Slightly over one quarter of the mothers reported being employed outside the home, 9 % reporting that they earned income at home. Partly due to maternity leave patterns, far fewer of the mothers of 0 to 2-month-old children were employed outside the home than those of older infants. Mothers who did work outside the home, tended to come from higher educational and socioeconomic strata and were perhaps more able to afford suitable supplementary foods for their young infant.

Although the effect of work appeared strong for mothers who worked outside the home, most mothers did not work out of the home. Most babies who were weaned early and supplemented early did not have working mothers. It thus seemed important to differentiate the set of factors that influenced the feeding choices of mothers who did not work away from home from the influences on those who did. When logistic regression was performed with each group separately, it became clear that women who did not work outside the home responded to different influences from those who did. The strongest and most consistent relationships for those who did not work outside the home, were with Bangkok born mothers and those with a higher income; both depressed the duration of breastfeeding. As to higher parity, it was associated with breastfeeding for at least 6 months but not 3 months.

For women working out of the home, virtually none of the standard set of factors explained differences in duration of breastfeeding: urban birth, income, and education, were not related to duration. This is, perhaps, a further demonstration of the extent to which working outside the home is a determinant of feeding patterns: if a woman works outside the home, her feeding patterns are so influenced by that fact, that virtually nothing else matters.

Since almost all births occurred in hospitals, these institutions and their associated health care practices became an important focus of the study. The hospitals in Bangkok tended to have very different patient profiles and mix of practices. Most mothers received prenatal care though they received little information on breastfeeding either during the prenatal care itself or in the immediate postpartum period. Hospital practices regarding prelacteal feeds, encouragement of breastfeeding, early contact of mother and child, and rooming-in, appeared to vary enormously and inconsistently, even within the same institution. As a result, a tremendous mix of experiences was reported by the mothers.

A number of health care practices were associated with infant feeding behavior. Contact between mother and infant during the hospital stay appeared to have a positive effect on breastfeeding initiation and a negative effect on the probability of early supplementation. Another practice of potential importance is the distribution of free samples of infant formula to mothers during their stay in the hospital. Although only 12 % of the women reported this practice, it can have a negative effect on breastfeeding initiation and duration, and was therefore a matter of concern. The effects appeared to vary in different groups of women.

For women who were at home, receipt of a formula sample in the hospital was significantly related to shorter breastfeeding duration, decreasing the odds of breastfeeding for 3 months. Thus, these women, the majority of Bangkok mothers, were more susceptible to the effects of health care practices, and presumably could be influenced to adopt more appropriate feeding patterns if health care practices were to change.

Early supplementation and shortened breastfeeding were the key feeding problems uncovered. Many of the factors associated with these practices appeared to be immutable, or at least difficult to modify by nutrition or health policy. Urban birth, family income, and whether mothers work for income, are unlikely to be changed by those interested in improving early infant nutrition. On the other hand, the health care system itself was a sensitive and much more easily accessible avenue for influence. Health care practices surrounding birth did appear to affect feeding practices, particularly among mothers who did not work out of the home, the majority. In addition, the practices in health care institutions seemed inconsistent and ready for thoughtful reexamination. Certainly, the promotion of early contact, early exclusive breastfeeding, rooming-in and discontinuation of formula samples on discharge, are neither radical nor difficult recommendations. Fortunately, the very professionals who are most concerned about maternal and child health do have some ability to influence hospital and health care service policy.

The information gathered by this study suggests that, of all interventions, those which change hospital practices may have the greatest potential for affecting the practices of women who do work outside the home and to improve current infant feeding patterns in Bangkok (Winikoff, Latham and Solimano 1986b). The hospitals could make a more concerted effort to provide an atmosphere conducive to breastfeeding initiation and continuation and to diminish the incentives for early supplementation. Policies that would promote these ends include:

1. Rooming-in for all mothers when not medically contraindicated.
2. Early contact between mother and baby after birth.

3. Improved education of health professionals in regard to breastfeeding so they can better transmit information and support to mothers.
4. Improved information on early infant care to mothers.
5. Discontinuation of free formula samples in maternity hospitals.
6. Discontinuation of low-price formula outlets in hospitals.
7. Development of specific instructional materials on how to manage breastfeeding for working women. In addition, policies specific to the needs of working women need to be studied.

Research on determinants of infant feeding practices in Semarang, Indonesia

Alfred Sauvy, the great French demographer, concerned himself with the human qualitative factor in economic development and asked whether “growth goes with quality or against it” (Sauvy 1963). In a sense, that is a fundamental motivating question in this study of infant feeding practices in Semarang, in the area of Central Java, in Indonesia. The findings raised the question whether the people had experienced improvements in their lives as a result of increased access to Western-trained medical professionals, hospitals and health care centers with modern medical technologies, and convenient, manufactured products. The case would be clearer if one were evaluating the effects of a specific public health campaign which sought to reduce mortality by vaccination of the populace; in this instance quality would accompany quantity. The position was not so clear in this case, where Western medical attitudes and behaviors may be undermining the habits which would provide the optimum nutrition possible for all infants (Winikoff, Latham and Solimano 1986a).

Such conclusions were not a cause for optimism. On the other hand, there may be ways to reverse some of the problems of lopsided development. Accordingly, this section will set out the major conclusions of the study and make recommendations for logical public health policies, which, when implemented, can contribute to infant and child survival in Indonesia by improving nutrition and health.

The typical household in this sample consisted of five people living in three rooms or less. The median aggregate family monthly income was 42,000 Rp, the then equivalent of US \$67. Slightly more than half had electricity, 44 % had a closed toilet, only 18 % had running water, and 6 % owned a refrigerator. Most families purchased their water daily.

Most of the sample was ethnically Javanese. The next largest group was Chinese. The median age of mothers was 26 years and they each had 2-3 children. Fifty-four percent were born in a city; most had little education, with a median of 5 years of schooling. One-quarter of them participated in the paid labor force.

The median age of the index children was 12 months; 51 % were females, 49 % males. Forty-four percent were born at home, 30 % at a maternity clinic, and the remainder at a midwife’s home or in public hospitals. Twenty-six percent of the births were attended by a traditional *dukun*, 58 % by a licensed midwife (*bidan*), and 14 % by a doctor. Most (95 %) had been breastfed at some time and only 8 % had been rehospitalized since birth.

Extended breastfeeding (up to 30 months) of high daily frequency (median of 11 feedings) was the norm. The predominant patterns of infant feeding were: (1) breastmilk and food supplements; and (2) some combination of breast, bottle, and foods. Unsupplemented

bottle-feeding, or breast and bottle-feeding, as the sole source of nutrients, were rare. On the other hand, 50 % of mothers reported having used infant formula at some time, from 10 % at 0-2 months to 50 % at 12-14 months. The very early introduction of solid foods was widespread. By 2 months, 56 % of infants received various types of foods.

Although breastfeeding was valued, the use of colostrum was not and prelacteal feeds were not uncommon. The almost universal use of formula milk for neonates in hospitals gave new mothers the impression that colostrum was not good for infants and that artificial milk is better than breastmilk. Although 72 % discarded colostrum, the fact that almost 30 % used it was a source of optimism. While women were aware of the multiplicity of benefits of breastfeeding, the yellow appearance of colostrum was sometimes considered unclean. Islamic tradition considers honey to be a purifying agent, and some women used it as a prelacteal feed. Since colostrum has a laxative effect, information emphasizing the similar functions of colostrum and honey, as well as clear explanations regarding the antibodies in colostrum, should be provided to pregnant women by health personnel, and again immediately after birth. Recognizing colostrum as a “purifier” may induce women to use it.

Overall, this culturally specific approach should be taken in response to what may be an “insufficient milk syndrome”. At least one-quarter of the sample reported experiencing decreased breastmilk, and 40 % stated that they knew their milk was insufficient because the milk was diluted. There may be an inaccurate expectation as to the color and consistency of breastmilk. This problem of insufficient milk warrants additional study.

Considering the high infant morbidity and mortality in Indonesia, it is not surprising that women are anxious about their ability to nourish their children. The most frequent responses to insufficient milk were to drink *jamu*, an herbal tea treatment consistent with humoral therapeutics, and to eat more fruits and vegetables. Health professionals should therefore encourage the greater use of *jamu* and the consumption of fruits and vegetables, along with an explanation of how an increase in the frequency of breastfeeding stimulates lactation. These recommendations are vital for women who tend to respond to perceived decreases in milk supply by using artificial formulas, since the latter may result in unfortunate, and unintended, premature weaning. Women who introduced bottles early in the lives of their infants did have a much shorter weaning interval. Too early introduction of artificial milk in bottles can interfere with the infant’s sucking response, leading to inadequate milk production and unwanted weaning: the “cure” deepens the problem.

At least half of the women who introduced artificial milk did so in order to decrease their breastmilk. They may have used this as a weaning method. Since pediatric recommendations were then that weaning not take place before 4-6 months, the traditional and still widespread method should be encouraged: lengthy breastfeeding and gradual weaning with a variety of locally produced foods, served with utensils other than bottles. Amenorrhea due to lactation assures reasonable spacing between births—an advantage to individual families as well as to a nation struggling with problems of an already large population.

Use of food supplements was universal. Foods appeared to be both ritually and ceremonially significant as well as nutritionally valued. All children consumed foods by 4 months of age: 50 % of those who were never breastfed received foods in the first month of

life vs 39 % of those who were breastfed. For women who are exclusively breastfeeding, the addition of foods is, at best, an unnecessary expense. At worst, it offers an additional medium for bacteriological contamination. Large quantities of foods can also cause disinterest in breastfeeding in infants whose hunger is satisfied.

Family income, mother's age, education and birthplace all influenced breast and bottle-feeding practices in Semarang. Although all women provided supplements, high income women introduced bottles and breastfed whereas lower income women supplemented with foods. The cumulative pressure of physicians, *bidans*, and peers encouraged the use of packaged cereals and formulas among wealthier women.

The major target groups in need of public health education and support, were on one hand, women without husbands or living in households of more than 10 people, and on the other hand, women from wealthier families who had greater access to western values, physicians, and advertisements promoting manufactured infant foods and formulas.

Poor women over the age of 35 and higher income women appeared to be at greatest risk of never breastfeeding. The use of formula is a greater detriment to poor children because it increases the possibility of unnecessary exposure to infectious agents in poorly cleaned bottles and in diluted formula. The cost of sterilizing bottles was significant for women who had to purchase water daily, who used unsterilized containers for storage, and boiled bottles on kerosene or wood braziers. The high cost of formula placed an additional constraint on meager daily wages.

There was a widely available variety of commercial infant foods with price competition between brands. Although the distribution of free samples was not widespread, one of the more interesting features of product promotion was the degree to which mothers in every birth setting, and with each type of birth attendant, reported receiving a free sample. It would appear that producers had not overlooked any point of contact with new mothers. Overall, there did not seem to be a strong orientation to using commercial infant foods at the time of the survey. There was, however, evidence that promotional marketing efforts existed nonetheless, and that those efforts appeared to be excessive for the apparent demand. If traditional infant feeding values were to be protected and encouraged, the health care system seemed to be the most important point of intervention.

Only 25 % of the sample was employed in income generating activities. Nonetheless, for these women, a number of factors related to paid labor force participation were closely linked to less than optimal infant feeding regimes. Working outside the home increased the likelihood of early bottle-feeding, although by itself it did not appear associated with shortened duration of breastfeeding. Women working in circumstances without day care facilities, or who were not allowed to keep their children with them, showed this pattern. Maternity leaves appeared to be rare. Many working women returned to work within 2 months with the consequent introduction of breastmilk substitutes.

Longer paid maternity leaves, on-site child care facilities with frequent feeding breaks, and the encouragement, only if absolutely necessary, of mixed feeding for mothers employed outside the home, would help to improve life conditions of working mothers and infants in Semarang. A higher minimum wage might reduce the necessity for some women

to work more than 7 hours a day and might allow other women to work part time, thereby encouraging exclusive breastfeeding or breastfeeding and appropriate supplementary food.

Giving birth at home, using the *dukun*, and rooming-in, all predisposed index mothers to high initiation and lengthy durations of breastfeeding. In comparison, women with hospital births, doctors, and *bidans*, who were separated from their children at birth, all had an increased chance of introducing formula feedings early and shorter durations of breastfeeding. There was clearly a basic need for additional education, or re-education, of *bidans*, physicians, and *dukuns*.

Cross sectional data indicate that *bidans* were a key element in the introduction of bottle formulas for weaning purposes, and as a response to problems of insufficient milk and breast morbidity. Both doctors and *bidans* who visited mothers immediately after birth influenced their decisions to use formula exclusively, or breastmilk and formula supplements. An ethnographer has indicated that *bidans* are particularly vulnerable to advertisements and readily distribute formula samples provided by manufacturers. The *dukun*, on the other hand, is positively associated with optimal breastfeeding habits. She also organizes rituals and ceremonies which provide social and psychological validation and communal recognition of the life cycle event of childbirth.

The life table analyses demonstrate that women using *bidans* breastfed their children for 9 months less than those using traditional *dukuns*. Physicians were equally, if not more seriously, implicated in practices which tended to shorten the duration of breastfeeding. Almost 60 % of the Semarang sample used *bidans* as birth attendants and 16 % used physicians. It follows, then, that changes in some of their less helpful practices would have a great effect on local community health.

One is struck by the degree of contradictory information and lack of knowledge on several important health issues among medical personnel. Information was seriously lacking on topics such as the effects of hormonal contraceptives on breastmilk production, the relative nutritional value of breastmilk *versus* artificial milks, the disease-protective properties of breastmilk, and the benefit of some traditional feeding habits. Women were simply not informed in health clinics that hormonal contraceptives may interfere with milk production. Again, health centers were not consistent in advising women to continue breastfeeding while they or their children were ill. Some centers distributed free samples of formula and cereals to all, but most often to under-nourished babies, inadvertently fostering the idea that they were superior infant foods.

These observations led logically to the following recommendations. Rooming-in should be the norm in hospitals. The professional health staff of medical clinics, hospitals and health centers should be educated in the virtual impossibility of disease-free bottle-feeding by poor clients, such as 35 % of this sample with access only to easily contaminated water. Pre-lacteal feeds in hospitals should not be offered. Immediate breastfeeding after birth should be promoted for well and ill babies, as well as the use of colostrum. No free formula samples should be given, especially to poor families because of the additional financial burden which would be placed on them if they tried to continue artificial feeding. *Bidans* and physicians must receive upgraded education on the unintended consequences of early bottle-feeding.

Health professionals should provide basic information to pregnant and lactating women emphasizing that bottle-fed infants are more susceptible to infections because they lack the protective mechanisms derived only from breastmilk. Women should be advised to continue breastfeeding if they or their children are ill. Since almost 90 % of the sample did receive prenatal care, information and advice should be begun during the prenatal period. All identified beneficial traditional practices, including exclusive breastfeeding on demand and prolonged weaning, should be promoted along with dissemination of information that exclusive breastfeeding can provide enough nutrients for the growth of infants up to 5 or 6 months of age. Fathers should be incorporated into any health education programs since they appeared to have considerable influence in advising their wives to use formulas and/or packaged cereals.

The formation of breastfeeding support groups similar to La Leche League of America is suggested. These could, perhaps, work through local women's organizations, to provide needed encouragement and education to women who are breastfeeding. It is possible that the *dukuns* could play some role here, since many women, regardless of class, appeared to respect their child rearing advice. Utilization of the *dukun* to disseminate advice to counter low milk supply by increasing the frequency of breastfeeding (encouraging women to drink more *jamu* and to use traditional massages, *etc.*) illustrates how to integrate both scientific knowledge of Western medicine and historically-recognized practices for medically efficacious outcomes. Health care in a society with dual medical traditions must provide treatments in ways which maintain respect for the cultural context of illness. Ethnographic information also revealed that *bidans* were concerned about differentiating themselves from the *dukuns*, since they had received training in the biomedical model of disease similar to physicians. This implied a concern with status and respect, and partially explains the intensity of their emulation of Western medical opinions regarding infant feeding.

The recommendations set forth throughout this last section can help to prevent continued erosion of traditional feeding practices. There is, however, another difficulty: the influence of world-wide communication which broadcasts the prosperity of the West in all of its aspects. The idea that parents everywhere could reproduce a portion of this prosperity in their own families through the use of formulas, for example, is seductive. The tendency to use formulas and packaged cereals, instead of breastfeeding and locally produced weaning foods, may reflect a rejection of cultural history.

It has been the primary interest of this research to increase the comprehension of individual and collective decisions regarding childhood nutrition and health, and to assess habits which increase survival. The findings have documented the effect of Western medical and industrial technology on families, through the use of free samples, poor medical advice, and subtle, but nonetheless, negative valuations of mothers by Western-trained health personnel. Policy changes suggested include rooming-in, paid maternity leaves, increased minimum wages, support groups, and programs to re-educate health workers and families (Winikoff, Latham and Solimano 1986a).

Impact of maternal employment on nutritional status in the Semarang area

Related to the part of the large USAID supported study conducted in Semarang in Indonesia, Soekirman conducted research for his Cornell PhD dissertation under Michael's

guidance. He examined the effect of maternal employment on the nutritional status of infants from low-income households, including various factors related to mothers' employment and their impact on breastfeeding and infant nutritional status. Here is the dissertation summary (Soekirman 1983) :

This study examines the effect of women's employment in factories in the Semarang area of Indonesia on infants' nutritional status. The sample consisted of 122 working and 177 nonworking mothers with infants 0 to 6 months of age from low-income households. The study was a post-only quasi-experimental design with non-equal comparison groups.

Multiple regression analysis using OLS and Logit techniques showed that mothers' employment in factories has a negative effect on their infants' nutritional status, compared to infants of mothers who are not working. This effect could be attributed partly to differences in breastfeeding practices and diarrhea episodes. On the average, the infants of the nonworking mothers were breastfed more and had a lower probability of having diarrhea than the infants of the working mothers. Yet, the negative effect of women's employment was significant only if the mothers worked more than 40 hours per week and were paid less than the basic minimum wage of Rp 16,000 per month. This implies that infant health is related not simply to mothers having less time for infant care, but also to mothers not having adequate additional income to spend on supplementary feeding and child care. In this case, the fathers' education seemed to have a positive effect on infants' nutritional status. When mothers worked more than 40 hours per week but were adequately paid, receiving at least the basic minimum wage, family income has a positive and significant effect on the nutritional status of the infants.

Dr. Soekirman's dissertation went on to state:

Information on the specific problems of working women in the study area were not collected, but they are probably similar to problems often reported in the press and faced by other low-income working women in factories in Indonesia. These problems are primarily related to a lack of law enforcement to protect women's rights for equal payment, maternity leave, menstruation leave, and nursing breaks. In addition, even when they are at home, working mothers tend to be neglected by community programs such as the village women's organizations (PKK) and weighing programs. It is recommended that the government take steps to enforce the laws relating to women's employment and also encourage the PKK and other community programs to pay more attention to low-income working mothers at the work site and at home. This study also suggests that the role of fathers in child care should not be neglected in programs aiming to improve family welfare (Soekirman 1983).

Triple nipple infant feeding

In many developing countries in the period from about 1960 until 1990, the decline in breastfeeding was due less to a total abandonment of breastfeeding, and more to the very early introduction of infant formula, cow's milk, and other foods, while continuing to breastfeed. Long before this "mixed feeding" became worrisome because of the greater danger of transmitting HIV, serious attention was given to this problem (Latham, Elliott, Winikoff, Kekovole *et al.* 1986). We coined the term "triple nipple infant feeding" when a very young infant was receiving milk from a mother's breasts, and on the same day receiving

infant formula from the nipple of a feeding bottle. UNICEF later used the term *triple nipple feeding* in a film on appropriate infant feeding.

An urban study in Kenya showed that at 0-2 months of age, 96 % of infants were being breastfed, but 24 % were also receiving infant formula, and 9 % cow's milk. At 2-4 months of age, 95 % were being breastfed, while 44 % were also receiving infant formula, and 14 % cow's milk (Latham, Elliott, Winikoff, Kekovole *et al.* 1986). Most of the infant formula was fed using a bottle and teat, much of this in households without an indoor toilet, running water, a turn on stove, or a refrigerator. This pattern of triple nipple infant feeding was reported also to be prevalent in Bogotá, Colombia. However more households in Bogotá than in Nairobi had running water, better sanitation, and refrigerators (Winikoff, Latham and Solimano 1986c).

From the Kenyan data, a good argument can be made against the concept of a sequential progression of breastfeeding stages upon which the WHO typology was based (WHO 1983). Changes may take place over time in the proportions of breastmilk and of substitutes fed to infants at different ages, but there were no data to suggest a transition, at least among poorer women, away from a high prevalence and long duration of breastfeeding. The evidence suggested that Kenyan women considered breastfeeding an interactive process, more than simply a source of nourishment. The pattern of almost universal prolonged and successful breastfeeding, overlaid with widespread supplementation with infant formula, especially in the first 6 months of life, was clearly not adequately represented by any of the stages in the WHO typology.

With the advent of the HIV/AIDS pandemic, the strong evidence that there are rather low rates of transmission of the virus from mother to infant during exclusive breastfeeding becomes even more important. Much higher rates of transmission occur where other feeding is used while the baby is breastfed. Importantly also, when mothers attempt only formula feeding, but on occasions breastfeed their infants, rates of HIV transmission to the infant *via* breastmilk increase. So triple nipple infant feeding is the worst option for the infant of a mother who is HIV positive.

The insufficient milk syndrome

Probably since early times there have been mothers who believe that they are producing insufficient breastmilk for their babies even when this is not the case. There have also sometimes been grandmothers and health workers wrongly advising mothers, even of very young infants who are growing well, that the breastmilk needs to be supplemented with some other food, now usually manufactured infant formula. So "insufficient milk" has long been cited as a major reason given by women for introducing other foods in the first 6 months of life, and often for the total termination of breastfeeding which many call *sevrage*. This latter phenomenon may be more common among the more affluent.

In the 1980s there were major debates on what came to be called the "insufficient milk syndrome." (Do we not, in northern countries, like to medicalize everything, and concretize this by giving a condition the title of "syndrome"?) The advocates of the syndrome stated that many women couldn't produce sufficient breastmilk for their very young infants. The implications were that a substitute for human milk was a necessity, even

in very early infancy. This view was, of course, attractive to the infant formula companies, who increasingly stressed the importance of “insufficient milk” in their writings (Greiner, Van Esterik and Latham 1981). It is in their economic interests to do so.

In a detailed review of the literature, including our own findings and observations, we concluded that (i) a vast majority of mothers were capable of producing sufficient breastmilk for the health and nutrition of their infants up to 4-6 months of age; (ii) fear of not having sufficient breastmilk, followed by the introduction of the bottle, or other feeding, to the young infant, was a cause of a reduction in breastmilk production. The stimulus to the nipple of more breastfeeding results in greater milk production. A false belief of inadequate production, leading to introduction of bottle-feeding, and then early *sevrage* from the breast, is a serious problem, especially for underprivileged mothers in non-industrialized countries.

A published debate on the issue appeared in the journal *Medical Anthropology* in 1981. Gussler and Briesemeister (1980) stated that the “insufficient milk syndrome” was a real phenomenon and “by far the major cause of early termination of breastfeeding”. At that time, Dr. Gussler was a medical anthropologist at Ross Laboratories, a major US manufacturer of infant formula using aggressive marketing techniques.

In a response to them in *Medical Anthropology*, Penny van Esterik and Michael (1981) stated:

Due in part to concessions made by Dr. Gussler, we now seem to agree about the following important points.

(1) Insufficient milk is a commonly stated reason for early discontinuation of breastfeeding and for supplementation of the infant during the first 6 months of life.

(2) Many factors associated with modernization, westernization, and urbanization contribute to insufficient milk, in part by placing a distance between mother and infant with reduction in sucking, in stimulation of the nipple, and then of breastmilk production.

(3) The supplementation of breastfeeding with bottle feeds, especially early in infancy, may seriously interfere with lactation and reduce the quantity of milk produced and thus be a major cause of insufficient milk.

(4) The most appropriate ‘treatment’ for the insufficient milk syndrome in a mother who wishes to breastfeed, is to try to increase milk production by putting the infant to the breast more frequently and in this way increasing stimulation to the nipple. The more common treatment is often to suggest more bottle feeds, and this is likely to worsen the situation by leading to a further decline in milk production.

(5) Frequent breastfeeding on demand, close contact between mother and infant, and support systems for the mother, are all desirable, but are not individually essential for successful lactation.

(6) There is a need for well designed and conducted studies on the ‘insufficient milk syndrome’ and on other factors related to the decline in breastfeeding.

There also seem to be some points of disagreement. Dr. Gussler does not seem to be willing to concede:

(1) that promotional practices, both past and present, by manufacturers of breastmilk substitutes may be an important contributing factor to the insufficient milk syndrome. She does not believe that this should be in the model, whereas we think that it should be. Corporation promotional practices and erroneous medical advice which encourage the unnecessary use of such substitutes is, we believe, a very important and common underlying cause of insufficient milk. Research is needed into the strengths of these influences in altering feeding behavior under different circumstances.

(2) that cultural attitudes and practices may be quite important in contributing to insufficient milk in many societies, especially when mothers are exclusively breastfeeding.

(3) that the practice of breastfeeding is possible in modern urban societies, and its decline is not inevitable with 'modernization', although obviously compromised by the form of 'modernization' occurring in the world (including China)(Van Esterik and Latham 1981).

Later, in an attempt to draw the attention of the medical community in East Africa to this controversy, Michael wrote (Latham 1982a):

Lactation is dependent on two hormones, namely oxytocin and prolactin. Oxytocin is responsible for the letdown reflex in breastfeeding. Prolactin both stimulates milk synthesis and secretion, and also seems to repress ovarian activity. Suckling at the breast encourages the release of prolactin. The maintenance of lactation is dependent on adequate nipple stimulation by the suckling infant. It is now evident that diminishing amounts of breastmilk production result from reduced nipple stimulation.

The cause of 'insufficient milk' may therefore often be that alternative feeding has replaced breastfeeding to a variable degree. Therefore, advice to provide a supplement, or more supplement, is almost always going to contribute to a reduction in breastmilk production. Supplementary bottle feeds for the infant is used as a 'cure' for insufficient milk when in fact it is the 'cause'.

The most appropriate treatment for the insufficient milk syndrome, in a mother who wishes to breastfeed, is to try to increase milk production by advising her to put the infant to the breast more frequently, and in this way increasing stimulation of the nipples. The common medical advice of suggesting more bottle feeds is likely to worsen the situation leading to a further decline in milk production, and eventual cessation of lactation. This is not to condemn supplementary feeding, especially after the infant is 6 months of age, but it is only to suggest that its use will almost inevitably contribute to a decline in milk production.

There is no doubt that insufficient milk is a frequently given reason for early discontinuation of breastfeeding, and for supplementation of the infant during the first 4 to 6 months of life. Several determinants, some associated with modernization, westernization and urbanization contribute to this phenomenon by placing a distance between mother and infant with reduction of suckling and then of milk production.

Bottle-feeding, especially in early infancy, may seriously interfere with lactation, and reduce the quantity of milk produced, and in this way may be a major cause of insufficient milk (Latham 1982a).

The Baby-friendly Hospital Initiative – does it influence breastfeeding?

With his many years of both research and advocacy, Michael was involved with the initiation of the Baby-friendly Hospital Initiative (BFHI), a joint WHO/UNICEF program launched in 1992. As a founding member of the World Alliance for Breastfeeding Action (WABA), and currently Co-Chair of its International Advisory Council, he was active in WABA's efforts to promote BFHI worldwide, but particularly in developing countries.

As late as 1998, there had been few attempts to evaluate BFHI, or to find out if it influenced breastfeeding practices, nor which of the 10 steps was most successful and which most difficult. Michael influenced his student Judy Pojda to undertake this in Belize as part of her PhD dissertation. Entitled "*Does the Baby-friendly Hospital Initiative influence breastfeeding?: A case study in Belize* (Pojda 1998), it was designed to determine if the BFHI influenced breastfeeding duration above and beyond known indicators such as maternal age, education, ethnicity, employment, socioeconomic status, attitudes, previous breastfeeding experience and the health of the mother and infant (Pojda and Latham 1997).

Variables from the BFHI global criteria for the *Ten steps to successful breastfeeding* were used to evaluate five government hospitals having expressed their intention to become certified as "Baby-friendly". An independent BFHI point system was developed in order to rank hospitals. Each was assigned individual "step" scores, as well as a total "ten step" BFHI score. A sample of 515 mothers who gave birth vaginally to healthy, singleton infants at these hospitals was followed for 4 months. Trained interviewers conducted structured interviews in the mothers' homes when the infants were 2, 8 and 16 weeks old. The outcome of full breastfeeding duration was estimated using survival analysis and Cox regression models; multiple linear analyses was used to study the relationships between predictor and socio-demographic variables affecting the outcome.

All the hospitals had relatively low total BFHI scores ranging from 37-58%. Survival curves suggested that several individual steps appeared to have an effect on the outcome. Cox regression models showed that total BFHI scores were not highly associated with the outcome; however, mothers' perceptions of baby-friendliness, as measured by a maternity experience scale constructed from the WHO/UNICEF BFHI criteria, were highly associated with the outcome (relative risk 0.983). Older mothers with healthy infants and previous breastfeeding experience, fully breastfed for longer durations.

Establishing a causal relationship between the BFHI and breastfeeding duration was difficult because whether or not a mother initiated or extended the duration of breastfeeding was affected by cultural and individual factors beyond the control of the BFHI. However, individual BFHI steps may have had a beneficial effect on lactation. A refined version of the maternity experience scale could be used to target women at risk of stopping fully breastfeeding prior to the recommended 4 to 6 months.

The Belize hospitals with the highest BFHI scores did not have the highest scores for exclusive breastfeeding at 4 months. But the hospital with the highest BFHI score did have 100 % of mothers fully or partially breastfeeding at 4 months. The overall results suggested that the BFHI may be important in improving breastfeeding duration.

The limitations and dangers of commerciogenic nutritious foods

Ready to use therapeutic foods (RUTFs) have been clearly demonstrated to be very effective in the hospital treatment of severe protein-energy malnutrition and in refugee camps and similar situations where there are large numbers of malnourished children in need of feeding and care. In both hospitals and refugee camps, RUTFs have the huge advantages of being very simple to use, usually well accepted, and having in one “food” all the nutrients necessary for the rehabilitation and growth of the young child. These benefits outweigh their somewhat high cost, relative to that of local foods. And, in most cases, RUTFs are provided by a donor agency, and are not purchased either by families using them, or out of the small food budgets of rural hospitals in developing countries (Collins 2007).

In 2008, a very controversial and important issue was being widely debated in nutrition circles: the appropriateness and the wisdom of extending the use of RUTFs beyond therapy for seriously malnourished children. By terming these “ready to use foods” (RUFs, dropping the T for therapeutic) strong forces are suggesting commercially made RUFs as an answer, even a panacea, for the widespread malnutrition prevalent in young children in most developing countries. Such a broad extension of their use to prevent undernutrition, or even to alleviate mild or moderate underweight, seems to be unwise, to have certain negative consequences, to be unsustainable, and at the very least, to be widely recommended only under a set of internationally acceptable guidelines. One thing is certain: their wide use will be potentially very profitable to large manufacturers who make and market these products.

Twenty-five years ago, a study was conducted on the use of commercially produced relatively low cost nutritious foods to reduce, or even eliminate malnutrition, in non-industrialized countries. The publication is entitled *The limitations and dangers of commerciogenic nutritious foods* (Popkin and Latham 1973). In 1973, particular stress was being placed on foods rich in protein. A detailed analysis of certain high protein commercial foods being promoted in India clearly showed major limitations in terms of their cost, their impact on the total nutrient intake of children when these were supplements to family diets, their cost in relation to incomes, untruthful advertising and promotion, their potentially negative impact on both employment and local agriculture, and their negative impact on foreign exchange. In their publication, Popkin and Latham (1973) state:

In the last few years, some consideration has been given to the relationship between nutrition, national development, and planning. However, this has not been translated into national food and nutrition policy. Where nutrition has been considered, the subsequent programs have often been unimaginative, and in many countries they have failed to reach those in greatest need. In some countries, there has been an unhealthy reliance on foreign technology and often a tendency to ignore the real socioeconomic considerations necessary to develop an effective program.

In many parts of the world, both in industrialized and nonindustrialized countries, the extremely poor are benefiting least from the existing social, health, and

nutrition services, and yet they are the persons most in need. Existing nutrition programs place too much emphasis on commercially processed foods, which for many social and economic reasons are not appropriate for the poor, and may, in fact, contribute to a deterioration rather than to an improvement in nutritional status.

Nutrition programs and policy have often placed much emphasis on low cost nutritious foods. These foods are usually dependent on commercial marketing. Various incentives have been introduced or proposed to encourage private investment and to enable the private sector to profitably develop such products. These have included: the provision of subsidies or loans to assist development and marketing efforts, special tax and other monetary incentives, duty-free import of machinery and materials, and lastly, guaranteed distribution of the final product through government supported programs and institutions.

The rationale for the development of low cost nutritious foods is the need to reduce the extent of serious malnutrition in a particular country or region. This objective has seldom been realized.

The limitations and the potential dangers of relying on commercially produced, low cost nutritious foods to reduce or eliminate malnutrition have neither been adequately investigated nor put in perspective. The involvement of vested interests has limited scrutiny of their negative effects.

Commerciogenic nutritious foods are defined as commercially produced products high in protein and designed mainly to reduce the seriousness and prevalence of protein-calorie malnutrition or to improve growth of children at risk. They include milk products for infant use, semisolid manufactured weaning foods, high protein snack foods and beverages, various commercial mixtures of cereal, legume, and oil seed flours, and similar products. Our discussion here is limited to the commercially marketed products. Clearly, the limitations discussed below do not refer to the free distribution of products either in famines or other emergencies, or as a government program.

In many parts of the world, the families most in need are barely within the market economy. Often, 50 to 80 % of the population are subsistence farmers relying on their own agriculture for most food needs. The rest are slum dwellers and squatters who purchase unprocessed or semiprocessed food in local markets. Needs besides food are often filled *via* barter trade, and there is little reliance on the formalized market system. The common denominator of all of those (over 100) products is that no product that relies on regular retail distribution is reaching the needy target groups. Other marketing difficulties have slowed the distribution of these products.

Related to the marketing problem is the relatively high cost of these products in relation to the incomes of the poor. Most commercially produced foods of this kind have costs connected with milling, processing, packaging, transportation, and advertising, which make them more expensive than traditional foods.

A problem with many of these food products has been that they are often a "fall out" of research and development in the United States and in other industrialized countries. They have not been prepared for the country in which they were marketed but often were marketed there in an attempt to recover previous research and

development outlays. An example of this is a textured vegetable product for which Archer Daniels Midland (a United States concern) received financial support from the United States Agency for International Development (AID) to test-market in Thailand.

Many commercial food products designed to solve nutritional problems in low income countries are based on agricultural products produced primarily in the rich countries. The industrialized countries, seeking an outlet for their own products, do so at the risk of harming the agriculture and the economy of the poorer recipient nations. One example is the wide use of soybeans in new foods for developing countries. The effects of these commerciogenic foods on foreign exchange are negative, and provide one more impetus for the use of local foods (Popkin and Latham 1973).

This general review and the detailed analysis of data from India, show a potentially dangerous effect of introducing commerciogenic nutritious foods into the diets of poor rural and urban families (Popkin and Latham 1973). This suggests the need for great caution in promoting such foods. In 1973, they were in general not contributing to the alleviation of malnutrition among the poor. Such caveats still seem relevant with the promotion of ready to use therapeutic foods (RUTFs) to prevent malnutrition in developing countries today.

The economic value of breastfeeding and breastmilk

Breastmilk is an important, often vital, food for millions of human beings in the world everyday and every year. Widely broadening the practice of breastfeeding is now recognized as perhaps the single most important measure to greatly reduce childhood malnutrition, and improve the health of children in most developing countries. Yet, very little attention is given to the economic value of breastmilk and breastfeeding. For example, food balance sheets which list foods produced, traded, and consumed in a country, do not list breastmilk.

In a 154 page monograph published in 1979, this issue was addressed in general terms, and also providing detailed results from research conducted in Ghana and the Ivory Coast (Greiner, Almroth and Latham 1979). Following are excerpts on this important point:

The economic value of human milk, like that of any food commodity, can be viewed in purely monetary terms. Indeed the pecuniary value of human milk is substantial and has been explored in a number of investigations. Data on costs of artificial infant foods, compared to food supplements for the lactating mother, have been used as a method to demonstrate the greater cost of artificial feeding. The accuracy of such estimates is improved by including the costs of utensils for bottle-feeding. Recent research has attempted to broaden thinking about the economics of infant feeding, for example to include the cost of time involved.

This paper, by enlarging on previous methodologies, proposes to improve the accuracy of past estimates of the economic value of human milk. It should be stressed from the outset, however, that this fails to do justice to the true economic value of human milk. If economics is viewed more broadly as concerning the way people allocate limited resources toward alternative means of improving the quality of life, a number of valuable non-monetary contributions of human milk emerge. Some of these can be more satisfactorily quantified along scales other than dollars and cents,

such as mortality, morbidity, or population growth. Others, though important even in an economic sense, are currently not quantifiable, such as psychological benefits. Finally, it is likely that all the benefits of human milk are not presently known.

Human milk can be viewed in many respects like other food commodities. For example, it could be stored in milk banks, and redistributed from areas of surplus to areas of scarcity. The Fourth World Food Survey includes a discussion of breastmilk, pointing out that, “Breastmilk is a commodity of very high nutritious value and low production cost which is potentially almost perfectly equitably distributed among the needy—something that, as has been shown, cannot be said about supplies of other types of food.” Breastmilk is perhaps also unique in that many of its benefits are associated more with its method of delivery than its physical or nutritional properties *per se*. Thus it would be more accurate to say that one is dealing not so much with the economic value of human milk as with the economic value of breastfeeding.

It is also pointed out that:

Clearly in Ghana, as in many other countries, breastfeeding contributes very substantially to a reduction in fertility, and is likely to be having more effect on child spacing than are all artificial methods of birth control combined. Therefore, in considering the economic and other consequences in a decline in breastfeeding, important note needs to be taken of this phenomenon (Greiner, Almroth and Latham 1979).

While it may be impossible to put a true value to breastfeeding in economic terms, we are also reminded that many governments make policy decisions based on less than perfect economic data. Based on this research in Ghana and the Ivory Coast, the total cost (including goods and time) of artificial feeding per mother for 2 years, was estimated to exceed that of breastfeeding by \$600 (1979 US dollars). It was concluded that in order for the data to be useful in the realm of public policy, it must be considered at the national level. Applying their model to the Ivory Coast, they estimated that if every infant was breastfed for 2 years, the annual savings would be between US \$16 and \$28 million, which is between 33 and 60 % of the 1976 health budget for the Ivory Coast. This showed that even in a country where the rate of breastfeeding was very high, the potential economic benefits that could result from a successful national effort to promote extended breastfeeding could be great. The group concluded that an increased rate of death and disease had followed the switch from breastfeeding to artificial feeding, but that the major impact of breastfeeding on economic development, through its health-promoting and birth spacing effects, could not be quantified given the knowledge at the time (Greiner, Almroth and Latham 1979).

Breastfeeding—a human right

Michael has, during much of his career, been a strong proponent of human rights, beginning with support for the 1948 *Universal Declaration of Human Rights*, and then, in his own academic field, for a greater concentration on human rights to adequate food and to health. Reviewing the broad literature ranging from the 1963 *Manifesto of the Special Assembly of Man's Right to Freedom from Hunger* to the present, he argued that breastfeeding was also a human right.

In the *International Journal of Children's Rights* he published an article entitled *Breastfeeding—a human rights issue?* (Latham 1997). Although the title asks a question, Michael concludes that indeed breastfeeding is an infant's right, whereas a mother's obligation to breastfeed her infant is not absolute. But he argues that if all obstacles that mothers face in regard to breastfeeding were removed, almost all mothers would choose to breastfeed their infant. Following are excerpts from this article:

Breastfeeding is acknowledged to be the optimal way both of feeding and caring for young infants. Human breastmilk provides the ideal food for the human infant. "Cow's milk is best for baby cows, human milk is best for babies" is an oft-quoted axiom.

There is no alternative. That it should be necessary to argue about the advantages of breastfeeding over other methods of infant feeding is wrong or even ludicrous. Do we argue in favour of breathing fresh air rather than oxygen from a respirator? In fact, to state that breastfeeding is "best" is to suggest that there are good alternatives. There are not. So rather we should state that other methods of feeding should be rare, and used only in extreme circumstances. We should not be lauding the advantages of breastfeeding any more than we praise the practice of breathing air. Rather we should be articulating clearly the harm and disadvantages of any alternative. We should not be stating that breastfed babies are healthier and have better psychological development than bottle-fed babies. Rather we should be saying that formula fed babies have more disease and lower intelligence than normal babies. And also that mothers who do not breastfeed their infants have higher risks of certain cancers.

Breastmilk contains the right mixture of protein, carbohydrate, fat, vitamins, and minerals to provide ideal nutrition for the baby, and alone, without any supplementation (not even water), provides the ideal complete diet for the first 6 months of life. Then, after other foods are introduced, it will continue for another year, or more, to supply important nutrients. But besides its value as a nutritious food, it is also a "living fluid" with live cells, and it provides anti-infectious constituents such as antibodies, lysozyme, lactoferrin, macrophages, leukocytes and lymphocytes, and also others not normally considered of dietary importance but of great importance to the health of the infant. It may also contain nutrients yet to be discovered or chemically isolated.

Breastfeeding, which is the art of feeding a baby from the breast, is a unique form of infant care which has been shown to be very important for infant development, including mental development (Latham 1995). Breastfeeding also provides benefits to the mother. These include clearly established health and psychological benefits, and also often social and economic benefits. Most breastfeeding mothers also state that it is enjoyable, some claiming that it is highly pleasurable.

For these reasons, the right of mothers to breastfeed their infant deserves to be accepted as a human right. Article 12 of the *International Covenant on Economic, Social, and Cultural Rights* clearly describes "the right to health," which is defined as "the enjoyment of the highest attainable standard of physical and mental health." It continues by listing steps to be taken by the states parties to the covenant to realize this right to health. The 1978 WHO/UNICEF conference on primary health care held

at Alma Ata resulted in the *Declaration of Alma Ata* which states that health is a human right, and it defines health as “complete physical, mental, and social well-being, and not mainly the absence of infirmity.

Surely, then, because for infants there is no other perfectly suitable food except breastmilk, because there are other health advantages for the infant resulting from breastfeeding, then infants who are not breastfed because of obstacles to breastfeeding have suffered unnecessarily. Because there are health and other disadvantages to the mother resulting from not breastfeeding, then obstacles to breastfeeding are also obstacles to the mother’s and infant’s human rights. All infants should, where possible, enjoy the right to be exclusively breastfed for the first 6 months of life, and to be breastfed into the second or third year after other foods are introduced. All mothers deserve the right to breastfeed their babies for the length of time that they want, and this is considered desirable for both her, and her baby (Latham 1997).

In this article, after reviewing human rights’ documents in some detail, Michael then enlarges on the case for breastfeeding as a human rights issue. He goes on with a short discussion on the decline in breastfeeding in many countries stating

...the fact that huge numbers of human infants do not get breastfed, and that mothers are influenced not to breastfeed their newborn babies, is a distortion of nature... and that breastfeeding in some countries became a minority, not a majority, way of infant feeding is aberrant.

These are the concluding paragraphs of the article:

“Human rights” are sometimes termed entitlements. Internationally they include recognition of certain items or forms of treatment that all persons deserve or to which they are entitled. It is then expected that societies will take steps to ensure that their members enjoy these rights or entitlements. This may be achieved in part by national legislation and national actions. But in the end it takes people and communities to ensure compliance and to take actions to help all enjoy their rights. The assumption is that all members of a community deserve at least certain minimal rights.

Certain basic rights have been included in international declarations, have been promulgated by authoritative international bodies as codes or standards for all societies or all nations, or have been incorporated in national constitutions. Some of these rights, ranging from the 1948 *Universal Declaration of Human Rights* to the 1989 *Convention on the Rights of the Child* have been outlined in the introduction to this paper. These and many other international documents establish human beings’ rights to health and to food, and even to good nutrition. If we accept these rights, then this paper argues that it is logical that mothers have rights to breastfeed. Breastmilk is the only ideal food to ensure the good health, proper development, and well-being of young infants. Breastfeeding also contributes to women’s health.

This logic then leads to acceptance that any obstacles to breastfeeding are infringements of human rights. Major negative influences on breastfeeding therefore contribute to loss of this human right, and any persons who place obstacles in the way of breastfeeding are parties to infringements of human rights.

Major negative influences on breastfeeding include (1) the health profession, hospital practices, and the medicalization of infant feeding; (2) the promotional and marketing practices of manufacturers of breastmilk substitutes; (3) failure of nations and communities to assist mothers both to breastfeed and work away from home; and (4) lack of community support for mothers to initiate, sustain, and maintain optimum breastfeeding.

The contention here is that mothers have a human right to breastfeed their infants, and that obstacles to this are infringements on this right. As with other rights, states have obligations to respect, protect, facilitate, and fulfill this right. The WHO/UNICEF *Innocenti Declaration on the Protection, Promotion and Support of Breastfeeding* (WHO/UNICEF 1990) provides a useful framework for nations to honour these states obligations.

This paper does not discuss in detail the possible tensions between infants' rights to be breastfed and mothers' rights to choose not to breastfeed. It is certainly not proposed that mothers who choose not to breastfeed their infants should be penalized, ridiculed, or prosecuted. Mothers need to have the freedom to choose how to feed their babies. But it is argued here that almost all mothers living under optimally baby friendly conditions would make the choice to breastfeed. This is shown in countries as diverse as Norway and Tanzania. Therefore, what is needed is actions to remove those obstacles to breastfeeding, many of which are discussed in this paper. In some countries, such as the United States, a major obstacle is the lack of knowledge that there is no good alternative to breastfeeding.

The argument made is that mothers have a legal right to breastfeed their babies if they chose to do so. Infants' interests in optimal health and nutrition may be jeopardized if not fed on human breastmilk, or even if not breastfed. This should be viewed in terms of ethical, moral or civic interests and duties, not as legal obligations on the mother deriving from legal rights of the infant.

We should help mothers understand the benefits of breastfeeding to themselves and their infants. We can then agree that states have responsibilities and obligations to respect, protect, support and promote the removal of all obstacles to breastfeeding. When this is achieved, it probably will be unusual for infants not to be breastfed (Latham 1997).

Diarrhea management—could aggressive promotion of oral rehydration solutions (ORS) have undermined breastfeeding

In the *Rational home management of diarrhea*, a paper published in the *Lancet*, Dr Stina Almroth and Michael review the part played by fluids and foods available at home in the management of diarrhea, and question the premise on which guidelines for diarrhea management have been based, guidelines which mainly aim to prevent dehydration (Almroth and Latham 1995). They review the important change from parenteral to oral rehydration, and the discovery that glucose enhances fluid absorption in the small intestine, which a *Lancet* editorial proclaimed was “potentially the most important medical advance this century” (Anon 1978). They then look beyond treatment of acute severe diarrhea in hospitals, to home management of diarrhea, and from the miraculous impact of glucose, to

the similar properties of simple carbohydrates in household foods, stating (Almroth and Latham 1995):

Thus, a solution that had been developed for treatment of dehydration in hospital was now presumed to be equally suitable for prevention of dehydration at home. By implication, it became the advocated treatment for diarrhoea even in the absence of dehydration.

Substances, which stimulate absorption of fluid from the intestine, and thereby help prevent and treat dehydration, are mainly nutrients such as carbohydrates and proteins, which are present in food. Although this was known when diarrhoeal disease control programmes were established, the potential usefulness of food in preventing and treating dehydration was largely ignored. Scientists in search of an improved oral solution—a super-ORS—did consider food, but only as a well-defined component of a precisely formulated solution. However, few boldly suggested that giving almost any food, with sufficient water, could prevent dehydration.

Reluctance to consider food for the prevention or treatment of dehydration may also have been due to the fact that in conventional clinical management of diarrhoea, food was usually excluded. According to Chung (1948), food withdrawal was based on two theoretical concepts that had never been critically tested: the appearance and number of stools as a valid measure of treatment success, and that food withdrawal would allow the intestines to rest and thereby hasten recovery. Chung (1948) disproved both concepts through a metabolic and a clinical study nearly 50 years ago, but did not convince many colleagues that feeding during diarrhoea was beneficial rather than detrimental. What may finally have initiated changes in treatment protocols was WHO's official blessing of the value of feeding during diarrhoea, promoted through the Control of Diarrhoeal Diseases Programme.

Feeding was, however, only encouraged for nutritional purposes and was thought to interfere with, rather than enhance, rehydration. It was recommended that food, including breastmilk, be withheld during the initial rehydration phase, commonly for 24 hours. As with starvation for the duration of diarrhoea, the practice of initial food restriction was based on untested theoretical concepts, and when tested, these concepts also proved incorrect.

It is an advantage to use a single formula in hospital settings where procedures are standardized, but not at home where there is great variation from one household to another. Yet recommendations for home treatment were made to resemble as closely as possible those for the hospital. Thus ORS would be the first recommendation; when this was not possible, a specific recipe for an ORS-like solution would be promoted; and as a last resort, caregivers would be advised to make use of a limited number of approved home fluids.

We consider such a restrictive approach to have been neither necessary nor helpful. The ORS formula is not a physiological ideal—although at times it has been considered to be. To the extent that fluid composition matters, it surely matters less at home, where the main objective is to treat diarrhoea and prevent, rather than treat, dehydration. The composition of foods and fluids prepared at home may be variable, but hardly to an extent that would be dangerous. Limitation of the number of

recommended home fluids and foods is unnecessary, and may be harmful, since caregivers may infer that fluids that are not recommended should not be given.

Perhaps because doctors managed diarrhoea by restricting food intake, it was assumed that mothers, too, were withholding food. Mothers commonly expressed concern about their children's poor appetite during diarrhoea, and made special efforts to feed them. We found in Lesotho that mothers were convinced that feeding, including breastfeeding, should continue during diarrhoea in order to keep the child strong. This conviction was so firmly held that virtually all the mothers and grandmothers we interviewed said they had refused to follow health workers' advice to stop feeding. We interpret these findings as evidence of skillful practices for managing diarrhoea, instead of dismissing cereal-based "grandmother solutions" because "if they had been effectively made and used, there would have been few deaths from diarrhoea". We prefer to ask how many deaths have been averted because cereal-based solutions were effectively made and used?

If the concept of Protection, Support, and Promotion were applied to the management of diarrhoea at home, perhaps the first priority should be to protect existing feeding practices, which will be beneficial from the point of view of hydration as well as nutrition. By not acknowledging and respecting existing practices in the community, we risk destroying them and even causing harm. In Lesotho, we found that a side effect of the promotion of ORS and sugar-salt solution was that dilute "water with sugar and salt" solution was given routinely even when infants did not have diarrhoea.

Irrational use of drugs for treatment of diarrhoea, according to WHO, is associated with problems such as diversion of attention from appropriate treatment, unnecessarily high treatment costs, and adverse reactions. Would this list not be an equally appropriate description of the consequences of the promotion of irrational use of ORS at home?

As failures of ORS at home have become apparent, more rational guidelines for the use of ORS have emerged. However, a programme for home management of diarrhoea will remain fundamentally irrational if built on the premise that ORS is the ideal therapy that should be used if at all possible. ORS is not needed for most cases of diarrhoea at home. Home-based fluids and foods may be at least as effective, and are simpler and cheaper. Rational use of ORS at home implies that it should be limited (Almroth and Latham 1995).

In Lesotho, research was undertaken to obtain data on home management of infant and young child diarrhea (Almroth, Mohale and Latham 1997). Qualitative data were obtained through focus groups and individual interviews with mothers, grandmothers and nurses in three different geographic locations. To have a point of reference, information was first obtained about foods and fluids given to healthy infants and young children, and later about what was fed during episodes of diarrhea.

This study provides evidence that beneficial diarrhea management practices have existed traditionally among women in Lesotho: home management of diarrhea had emphasized feeding. While medical advice in the past recommended that, except for breastfeeding, food should be withheld during diarrhea, mothers, grandmothers, and even nurses, had been reluctant to follow this advice. Mothers and grandmothers saw feeding as

so essential that they would make special efforts to feed a child with diarrhea. Since most foods contain protein and carbohydrates which stimulate intestinal fluid absorption, feeding during diarrhea, besides maintaining nutrition, will help maintain hydration. Before planning an intervention, existing practices should be assessed, so that whenever possible such helpful practices can be protected and supported. There is then less need to promote new practices and less risk of causing harm.

Another study in Lesotho investigated unnecessary water supplementation for breastfed babies in a culture where breastfeeding is the norm (Almroth, Latham and Mohale 2000). It was designed to obtain policy- and program-relevant data on exclusive breastfeeding at a time when global recommendations for exclusive breastfeeding were new. During both phases of field research conducted in 1991 and 1992, qualitative information was obtained through focus groups and individual interviews with mothers, grandmothers and nurses. This was complemented during the second phase with quantitative data collected through a clinic-based survey of mothers. The qualitative and the quantitative findings consistently converged, illustrating a culture of infant feeding in which breastfeeding was central, but exclusive breastfeeding was an unknown concept and was not practiced. Grandmothers seemed to be more in tune with the ideal of exclusive breastfeeding as they had given their young infants thin gruel only occasionally. Contemporary mothers, in contrast, were regularly giving their young infants water. Mothers and grandmothers frequently cited nurses as the source of advice for giving water. Grandmothers were adamant in pointing out that they had never given water to their own young infants and asserted that they avoided giving it to their grandchildren as they considered it unnecessary and harmful. According to the grandmothers, water supplementation was a new practice that had been introduced through the clinics. It was concluded that efforts to discourage water supplementation and encourage exclusive breastfeeding in Lesotho, and probably elsewhere, need to be directed at both mothers and community health workers.

Breastfeeding and HIV – a four country study

In 2001 UNICEF sponsored a study to investigate the apparent decline in support for breastfeeding in the context of the HIV/AIDS pandemic in sub-Saharan Africa and asked Michael to conduct it, along with Pauline Kisanga of IBFAN, Africa. The overall objective was to assess the situation of protection, support and promotion of breastfeeding in four countries—Botswana, Kenya, Namibia and Uganda, and to determine possible reasons for the perceived decline. A further objective was to make recommendations on how the implementation of infant feeding policies in the region might be improved. The results are published in a 90 page UNICEF (ESARO) report (Latham and Kisanga 2001).

Both authors had in previous years expressed serious concern about declining action to protect, support and promote breastfeeding and young child feeding in sub-Saharan Africa, by both governments and United Nations agencies. Children have the right to adequate nutrition, and for infants and young children, breastfeeding is a key element. For over 20 years, IBFAN has shown a commitment to, and has campaigned effectively for, the right of mothers to choose the best possible feeding method for their babies, in the full knowledge of the health and other benefits of breastfeeding, and with freedom from commercial pressure and misinformation which industry often uses to promote breastmilk substitutes.

The United Nations agencies, and particularly UNICEF, have played major roles in the past, being very instrumental in spearheading global initiatives that have formed the basis for implementing infant feeding policies. These include, the *International Code of Marketing of Breast-milk Substitutes* (1981) and subsequent relevant World Health Assembly resolutions, the *Ten Steps to Successful Breastfeeding in Health Facilities* (1989), the *Innocenti Declaration* and the *Convention on the Rights of the Child* (1990); and in 1991 the *Baby-friendly Hospital Initiative* (BFHI) as a tool to implement the Ten Steps.

In this four country study, the authors used a participatory approach, interviewing stakeholders and relevant persons and organizations, seeking their opinions, making observations at various sites, studying documentation and reports, and reviewing actions to support breastfeeding, particularly in the last 2-3 years. They concluded that:

It is absolutely clear that actions to protect, support and promote breastfeeding have declined very markedly in Botswana, Kenya, Namibia and Uganda, in recent years. This conclusion is based on discussions with well over 100 knowledgeable persons in the four countries. These individuals represented a wide range of experience and expertise. They included a Minister for Health; a Member of Parliament; senior officers in the Ministries of Health; government officials in other ministries; NGO leaders; the UNICEF Representative in three countries, and UNICEF programme officers in all four countries; WHO staff in all four countries; and many others.

Almost all agreed with the above conclusion, and many stated strongly that this decline in support for breastfeeding was very unfortunate, and that efforts should be taken to reverse and remedy it. We found, in recent years, a dwindling support by UNICEF for breastfeeding, at a time when governments have tighter budgets and reduced funding for breastfeeding because they see other priorities. The need for UNICEF, WHO and others to provide much greater support for both nutrition and breastfeeding is clear. In all four countries the Nutrition Units (or equivalent nutrition focal points) are weak, and are in dire need of strengthening. This often requires more well-trained staff, increased funding, and greater status within the government. This could be assisted if UNICEF offices had Nutrition Programme Officers, who as well as supporting breastfeeding could also be promoting dwindling activities in areas such as growth monitoring and promotion; immunizations; control of parasitic infections and diarrhoea; reduction of micronutrient deficiencies; improvement in food security; and others. New programmes such as IMCI and Early Child Development hold promise, and could be used in support of breastfeeding. They should embrace, and build on, activities such as BFHI, the Code, Breastfeeding Week, and the work of breastfeeding NGOs (Latham and Kisanga 2001).

These conclusions relate to African countries where the authors consider, and almost all others agree, that there is very strongly based cultural support for breastfeeding. Breastfeeding remains the cultural norm, firmly imbedded in the community, and for almost all mothers, not breastfeeding is considered aberrant. But parallel with this, a marked decline in support services for breastfeeding has occurred. Mothers who have any breastfeeding related problems find it more difficult, than in the past, to get support and assistance. That breastfeeding remains the accepted norm is encouraging because, although damage has been done, preventive measures could be taken to repair the damage, or even reverse the situation. This will require greatly enhanced commitments and support from

UNICEF and WHO, but also from governments, non-government organisations (NGOs), and others. The UNICEF paper describes in some detail particular areas where protection, support and promotion for breastfeeding have declined in the four countries (Latham and Kisanga 2001). These include:

The Baby-friendly Hospital Initiative

The situation of BFHI in the countries differs. Namibia by 1995 was said to have all (or almost all) hospitals with maternity units declared “baby-friendly,” while Uganda, with far more units, had only one. But our concern is that this effort, generally regarded as successful, appears to have almost ceased, or is paralyzed. In none of the four countries did we learn of current real efforts, either to promote BFHI in hospitals, nor to monitor those that were certified and would benefit from support to continue to adhere to the 10 steps. The “crisis,” as well as the different efforts directed at PMTCT¹ could be used as a springboard to reinitiate very strong support for BFHI. These were WHO and UNICEF initiatives that deserve support (Latham and Kisanga 2001).

The International Code of Marketing of Breast-milk Substitutes

The Code and subsequent WHA resolutions are generally regarded as very important instruments that had an important impact, and greatly reduced overt promotion of infant formula by the transnational corporations who manufacture these products. Despite continuing serious infringements by these corporations, nevertheless with vigilance from IBFAN and others, there is now less overt advertising of breastmilk substitutes, and gone are the days when so called “milk nurses” promoted their wares uninterrupted in hospitals around the world.

The Code, and the amendments to it, remains an effective instrument to prevent a decline in breastfeeding in those countries where it is the norm. Yet activities in support of the Code appear to have declined. The Code is at different stages of development, or in different forms, in the four countries visited. Uganda has a Code that was officially gazetted as law in 1997, but it is not well known, nor enforced. Botswana drafted a Code in 1997, but this never led to legislation.

The WHO Code is well recognized in the three-guideline booklets on MTCT² issued by UNAIDS/WHO/UNICEF in 1998. In fact because of concerns of MTCT through breastmilk, violations of the Code are more likely than ever to occur. Infant formula manufacturers now see an opportunity to subvert, or even nullify the Code, and this will be easier for them in countries that do not have Code legislation. The Code is as important as it ever was, and needs to be monitored and enforced.

Yet, like activities in support of BFHI, our discussions in three of the countries led us to believe that actions in support of the Code were frozen, *in situ*, between 1995-1997, and little attention or action is taking place now. There is no evidence of strict monitoring or enforcement.

However in Kenya, there is renewed interest. Three persons (a Programme Officer from UNICEF, a paediatrician from Kenyatta National Hospital, and a lawyer from the office of the Kenya Attorney General) recently attended the IBFAN Code

¹ PMTCT : preventing mother-to-child transmission

² MTCT : mother-to-child transmission

compliance course held regularly in Penang, Malaysia. As a result there is now some resolve to move the Code from the Bureau of Standards to the Ministry of Health where it belongs. If, and when that happens, the young woman lawyer from the Attorney general's office is enthusiastic about drawing up legislation, leading to parliamentary approval, and real enforcement (Latham and Kisanga 2001).

World Breastfeeding Week (BFW)

World Breastfeeding Week is an activity initiated by the World Alliance for Breastfeeding Action (WABA) soon after WABA was born 10 years ago in the headquarters building of UNICEF in New York with the then Executive Director James Grant in attendance. Each year the WABA Steering Group decides on an appropriate topic for the week, and produces an action folder on breastfeeding in relation to the topic, including suggestions for community actions. Topics have included BFHI, the Code, breastfeeding as an environmental issue, the economics of breastfeeding; and now breastfeeding as a human right (2000), and others.

Breastfeeding Week is widely acknowledged to have been WABA's most successful action in support of breastfeeding; it is actively celebrated in over 130 countries north and south, east and west, each year, but not just in the capital cities, it often is in each small town, and in many rural villages. It is an important advocacy tool. The impact has never been evaluated, but is surely large. Often UNICEF and WHO country offices support BFW activities. In the past in many countries the Minister for Health launched the week, much publicity was gained, but more importantly local people at all levels of society (women, children and even men) were involved in action to protect, support and promote breastfeeding.

In the four countries we visited, Breastfeeding Week is still maintained and is supported by local NGOs. It is usually held in August, but Uganda (because support arrived late) was to hold its BFW in November 2000. However there has been dwindling support from the UN agencies, and because breastfeeding NGOs are weaker, and perhaps because of HIV/AIDS, support for this important activity has dwindled in recent years. On the positive side, the Minister of Health in Botswana had made a speech in Gaborone to launch BFW. On the negative side, one UNICEF Programme Officer dealing with health and nutrition was very denigrating about the value of Breastfeeding Week.

We believe support needs to be revived and strengthened. WABA certainly will continue to need at least a modest amount of funding from donor nations such as the Netherlands, Sweden and Norway, but surely also from WHO, UNICEF and perhaps other international agencies (Latham and Kisanga 2001).

Breastfeeding non-government organisations (NGOs)

In the past there were strong well-supported NGOs, which worked to support breastfeeding and played active roles in terms of the Code, Breastfeeding Week and especially in assisting breastfeeding support groups for mothers. Many of these NGOs made very significant contributions in many different ways to protect, support and promote breastfeeding.

In the year 2000 we found, in all four countries, that these breastfeeding NGOs were in a pitiful state. Some have died; others struggle but have practically no funding or staff; others limp along led by individuals with no training in lactation

management; and several have only stayed alive because one, or two unpaid volunteers have maintained a semblance of an NGO from their own residence (Latham and Kisanga 2001).

The impact of HIV/AIDS on breastfeeding

The report by Latham and Kisanga (2001) continues by reviewing in detail the relationship of the decline in support for breastfeeding and the current seriously high prevalence of HIV/AIDS in Botswana, Kenya, Namibia and Uganda.

There was close to unanimous agreement that the decline in support for breastfeeding was related to the HIV/AIDS pandemic sweeping these countries, including publicity based on scientific evidence, that mothers could infect their infants through breastfeeding. An important overall conclusion of our visits to the four countries and especially in Kenya and Botswana, is that there has been a massive spillover effect in which concern for HIV/AIDS has been transferred into deterioration in actions to support breastfeeding. Although totally unwarranted, there is a hidden unspoken fear that actions to promote breastfeeding might be construed as actions that worsen the HIV/AIDS situation in a country.

Two major factors contribute to this, both of which are discussed in this report. The first is a very widely held false view that almost all mothers who are HIV positive will infect their infants through breastfeeding. The second is a very low recognition at all levels (senior MOH officials, front line health workers, UN agency staff, the public and others) of the extremely high risks resulting when, from birth, an infant in a poor family is formula fed (a risk that in fact has never been adequately determined in a poor African community).

Here we wish to differentiate between a marked decline in actions in support of breastfeeding, and a decline in the prevalence and duration of breastfeeding. We are completely convinced that there is a decline in support for breastfeeding. We were not able to collect evidence to suggest, at this time, any very significant decline in the high prevalence, and long duration of breastfeeding normally practiced in all four countries.

Perhaps mothers, and African families, have the wisdom to continue breastfeeding as usual, despite news of the current “dangers of breastfeeding.” Some mothers have not received this “news,” but many others have and are still choosing to maintain breastfeeding despite what they hear on the radio, read in the newspapers or learn from scientific studies *via* health workers.

There may have been a significant decline in breastfeeding, especially among more affluent mothers. We do not know. But it seems as if the period between 1999 and 2002 could be crucial, and possibly disastrous for breastfeeding in sub-Saharan Africa. That is, if the concerns about MTCT are translated into major heavily funded efforts to convince mothers to avoid all breastfeeding, either because they are HIV positive, or although not tested believe they may be HIV positive. Without very convincing research and evaluation to show that such policies will do good, not harm, the above scenario needs to be most strongly resisted.

Clearly the spillover impact of HIV/AIDS on breastfeeding differs between the four countries, and is probably somewhat related to the extent to which

governments (often with influence from UN agencies and expatriate scientists) have moved in the direction of supporting, or recommending the use of formula as an important feeding method for mothers positive for HIV. So in this respect (as stated in our report) there is a difference between Botswana and Kenya on the one hand and Namibia on the other.

It is very important that serious actions be taken to prevent this spillover effect in which implementation of pilot projects, or larger programmes assisting HIV positive mothers to formula feed, results in substantial numbers of mothers who are HIV negative having doubts or fears about breastfeeding. In Uganda data suggest that 86 % of urban mothers attending antenatal clinics in Kampala are HIV negative.

It is important to consider the need for risk assessment and how such risks depend on different circumstances. If the only consideration is to reduce transmission of HIV through breastfeeding then mothers should not breastfeed if they are HIV positive. But if the objective of advice and policy is to do the most good or do the least harm, then the broad range of risks for mothers who opt not to breastfeed their infant from the day of birth, need to be very carefully considered. The pilot PMTCT projects now being undertaken in Botswana, Kenya and Uganda are large African experiments using human subjects. They need to be independently evaluated. It surely will be unethical to expand these interventions without a proper evaluation of the outcomes in terms of human wellbeing.

With new support for breastfeeding, the opportunity exists to take action, including advocacy and education, to increase substantially the extent of exclusive breastfeeding. This is said to be relatively high in Uganda but much lower than desirable in all four countries. Increased levels of exclusive breastfeeding would have tremendous benefits, irrespective of the HIV status of the mother. And it needs to be recognized that in the immediate future in these four countries, it is unlikely that the majority of pregnant women will be tested for HIV. In all four countries the majority of women, when tested, are found to be HIV negative (there is a wide range from 55 % negative in cities in Botswana to 92 % negative in rural Uganda). Exclusive breastfeeding has great advantages for almost all mothers in sub-Saharan Africa. In all four countries we found inadequate knowledge of studies showing that exclusive breastfeeding markedly lowers transmission of HIV through breastmilk. As has been stated later there is in general, an exaggerated belief in the likelihood that breastfeeding will infect an infant with the virus; and a very gross underestimate of the risks of formula feeding infants from birth in poor families.

Policies on HIV/AIDS and PMTCT have greatly influenced the status of protection, support and promotion of breastfeeding in the four countries visited. Our visits to Kenya, Namibia, Botswana and Uganda revealed strikingly wide differences in the national policies directed at PMTCT. Yet the four countries all:

- Have a relatively high prevalence of pregnant women who are HIV sero- positive.
- Have strong breastfeeding cultures with extremely high prevalence of breastfeeding in early infancy.
- Have access to the same scientific literature on risks of HIV transmission, and on the risks of not breastfeeding.

An important question is why have countries responded so differently. Some countries do not have a clear national policy on PMTCT, but in all there are government agencies moving ahead with advice, or there are draft policies, or there have been parliamentary statements, and in three countries there are pilot projects on PMTCT. Our report deals in some detail with where, we believe, each of the four countries is in relation to a PMTCT national policy (Latham and Kisanga 2001).

The study very clearly revealed that misconceptions, exaggeration of the risks of transmission of HIV *via* breastmilk, and inadequate knowledge of the many benefits of breastfeeding, have seriously contributed negatively to the attitudes to breastfeeding in all four countries. In their report to UNICEF, Latham and Kisanga (2001) state:

The very best way, in our view, to reduce and prevent mother to child transmission of HIV is for couples who are HIV positive to avoid a pregnancy (or even where permissible and legal, to seek an early termination of pregnancy). We believe that aggressive, and vigorous counseling, and access to family planning for women who are HIV positive, or who think they might be HIV positive, are all very important. Clearly women, even if HIV positive, have a right to bear a child, and that right must be protected. But in all four countries there is much discussion about PMTCT, and we found often confused or conflicting policy recommendations. But prevention of mother to child transmission by publicity, counseling and other actions to promote birth control is largely ignored.

We found in all four countries at almost every level of sophistication that knowledge of the relative risks of breastfeeding *versus* formula (or alternative feeding) was extremely poor. As stated, in general, there is an exaggerated belief in the risk of viral transmission through breastfeeding and a very much unappreciated knowledge of the high risks in formula feeding from birth in poor families. It seems vital that persons involved at all levels have a reasonable knowledge of these relative risks.

This lack of knowledge was extremely widespread and included highly placed officials in Ministries of Health; persons responsible for national AIDS policy; programme officers in UNICEF, WHO and UNAIDS; front line health workers; and not unexpectedly, ordinary citizens (Latham and Kisanga 2001).

In Kenya, Uganda, and Botswana there were, in 2001, major projects, some supported by UNICEF, in which HIV positive mothers were offered free infant formula as an option for feeding their infant. The objective was presumably to reduce transmission of HIV to the infant through breastmilk. Examining these projects on the ground in all three countries revealed major problems. Most importantly, mothers were not being adequately informed about the advantages of breastfeeding, including the importance of breastfeeding in reducing morbidity and mortality. The projects also were not providing adequate information of the large risks of “mixed feeding” (formula and breast) for those choosing to use breastmilk substitutes. For example, Latham and Kisanga state (2001):

The medical doctor running the pilot PMTCT trials at Msambya Hospital in Kampala stated that to contemplate using infant formula in place of breastfeeding in rural districts of Uganda was unthinkable. Msambya Hospital, is a private hospital, serving better off Ugandans, and women enrolled in the PMTCT trial there are often not exclusively formula feeding, rates of acceptance of formula have been low, and

more than once the supply of formula has run out during the first 6 months of the project.

Based on our findings, and the views of many professionals who really understand current conditions for most poor families in these four African countries, “going to scale” with formula feeding seems unsupportable. To do this without an independent thorough evaluation of the relative risks cannot be justified. Pilot sites are not truly “pilot sites,” if they are not very thoroughly evaluated. But we were not made aware of plans for any adequate evaluation of the relative risks for infants, mothers and families where the option was taken not to breastfeed in poor communities.

We support attempts to increase voluntary counseling and testing (VCT) where counseling can be provided by persons trained to assess relative risks of infant feeding methods. But VCT of this kind is not now widely available. And evaluation of the PMTCT pilot site results would provide all with better assessments of these risks.

After VCT, mothers have a right to be advised about the relative risks of alternative feeding options, to make a choice, and be assisted to fulfill their choice. But it should be understood that persons seeking advice from health facilities would usually ask the health worker which option he or she would follow. We all do that when we seek medical advice. This reinforces the importance first of knowing more about relative risks; second the need for evaluation of relative risks in typical communities; and third good training and proper understanding of risks by counselors and health workers (Latham and Kisanga 2001).

Breastfeeding and HIV

In the late 1980s, evidence showed that HIV could be transmitted to infants not only in *utero*, and during childbirth, but also from the virus in breastmilk. This has resulted in 20 years of debate and uncertainty about what decisions pregnant women who are HIV positive should make regarding feeding their newborn. An early response by UN agencies, including WHO and UNICEF, was to recommend that HIV positive women not breastfeed their infants, and should rather use infant formula, or other breastmilk substitutes. The debate was also influenced after it was discovered that providing zidovudine (an anti-retroviral drug) to the mother just prior to delivery markedly reduced HIV transmission from mother to infant perinatally. This soon got widely adopted with policies to provide zidovudine treatment in the last days of pregnancy, but to discontinue this for the mother after delivery. Michael, with Ted Greiner, suggested in a *Lancet* paper that “this strategy seems justified, but raises ethical issues for physicians who are expected to discontinue treatment of the mother after the birth of the infant” (Latham and Greiner 1998). Michael and Ted Greiner (1998) were also among the first scientists seriously to question the wisdom of advocating formula rather than breastfeeding by HIV positive mothers in poor families in non-industrialized countries. They stressed the importance of examining relative risks stating:

More troubling are the new proposals to conduct large-scale trials in several developing countries to replace breastfeeding with formula feeding in HIV-1-positive mothers. These is a small risk of transmission of HIV-1 from mothers to infants through breastmilk, and every pregnant woman who knows she is HIV-1 positive has

a difficult decision to make. The choice not to breastfeed is especially difficult for poor women in developing countries. Such women have inadequate access to resources, including breastmilk substitutes, plus equipment, fuel, and also education and health care. The decision not to breastfeed increases the risks of early pregnancy and birth of another HIV-1 infected infant.

Formula feeding by poor mothers in African countries rarely has involved no breastfeeding at all, from the day of birth. As a result, there is no good research to show how high morbidity and mortality rates will be in infants who are formula fed; these rates may be much higher than those described in newly industrialized countries such as Brazil and Malaysia.

We are concerned that WHO and UNICEF will invest major resources in formula feeding and few into alternatives, such as modified breastfeeding, heat treatment of expressed breastmilk to kill the virus, wet nursing, donation (or even sales) of breastmilk, and use of animal milks or homemade formulas. These options are preferable to the use of infant formulas in poor communities. None of them are easy, nor ideal, but they warrant careful study. Much of the successful work over the years to stem the use of commercial breastmilk substitutes in poor countries is now threatened. The involvement of the commercial infant formula industry, both in deliberations leading to the new policy and also in offering to make their products available, is troubling.

We recommend that the UN agencies assess carefully the economic, social, and health consequences of their new policies and that they provide adequate support to allow investigations of alternative methods. It is a grotesque reality that all HIV-1 infected mothers cannot have full coverage of antiretroviral therapy, that so many mothers and infants do not have access to adequate health care, and that inequities lead to a high prevalence of malnutrition. Given this unfortunate situation, is it wise to be recommending the costly and risky approach of formula feeding for infants born to poor HIV-1 infected mothers (Latham and Greiner 1998) ?

There is often an assumption that if a woman decides not to breastfeed her newborn infant, then she will opt to formula feed. It is true that infant formula, in most respects, is nutritionally the best alternative to breastmilk. But it may not be affordable, acceptable or safe. In an article in the *British Medical Journal*, Michael reviewed alternative infant feeding methods for mothers with HIV in developing countries (Latham 1999a). He wrote:

The many disadvantages and harmful outcomes, of artificial feeding have been widely documented, and apply to all societies, and at all levels of affluence and poverty. But in terms of rates of serious morbidity and mortality, it is recognized that risks are much higher in poor households with inadequate sanitation, unsafe scarce water supplies, no refrigeration, poor health services and little knowledge of hygiene. As a result the advice regarding infant feeding for a mother infected with HIV might be different if she is affluent compared with if she is poor. It is always very uncomfortable where advice regarding important health actions is openly stated to be different for rich compared with poor people. But it is a grotesque reality that the world is plagued by inequity, and that the gap between rich people and poor people, rich nations and poor nations is widening.

Every pregnant woman who knows she is HIV positive has a difficult decision to make, but the choice not to breastfeed is much more problematical for

poor women living in developing countries, than affluent women in northern countries. Poor women have hideously inadequate access to resources. These not only include those necessary to obtain sufficient breastmilk substitutes, plus equipment, fuel and potable water to prepare it safely, but also knowledge, healthcare, and time. Many women do not have access to, or knowledge of birth control measures. A mother not breastfeeding, is much more likely soon to get pregnant again, further endangering her own health and that of the next infant, who is also at risk of HIV, and of becoming an orphan (Latham 1999a).

In another paper, Michael addresses in detail the alternative feeding methods for mothers with HIV, flagging the advantages and disadvantages of each and discussing some research needs (Latham 1999b). Emphasis is placed on non-affluent families in sub-Saharan Africa. Affluent women are more likely to be able safely to formula feed their infants.

The alternatives discussed are:

1. Formula feeding from birth with no breastfeeding
2. Routine breastfeeding, including 6 months of exclusive breastfeeding
3. Modified breastfeeding
4. Expressed heat-treated own breastmilk
5. Wet nursing or cross nursing
6. Milk banks, milk clubs and milk donations
7. Animal milk or homemade formula.

After a detailed discussion of each of these seven alternatives the article concludes:

It is a grotesque fact that most families in Africa live in poverty without access to adequate health services. Therefore it is not generally possible for HIV infected Africans to receive the same level of treatment as is commonly used for HIV cases in industrialized countries. Similarly there is little likelihood that the majority of families can in the next decade achieve levels of living to allow them to formula feed an infant as relatively safely as is possible in northern countries.

Because of this the public policy should be that the majority of HIV infected pregnant women be counseled on the risks of different feeding methods, but most be discouraged from formula feeding. It is my belief that in most African countries if a policy were adopted similar to that of the U.S. Center for Disease Control and Prevention, then the reduced deaths resulting from HIV in infancy, would be offset with higher infant, and young child deaths from other causes, plus other undesirable outcomes discussed in the paper. These include poorer subsequent health and development in the child, and the likelihood of an earlier pregnancy plus the possibility, then, of the birth of another HIV baby destined also to be an orphan.

The policy decisions for public health, plus the counseling of the individual mother, need to include an evaluation of relative risks. Unfortunately scientific data do not allow these risks to be very definitively stated. This is a priority area for research (Latham 1999b).

In 1999, in an Editorial in the *British Medical Journal*, Michael expressed serious concerns about the rush to persuade HIV infected women not to breastfeed their infants, without due consideration of relative risks (Latham, 1999a). In this editorial, he states:

Years of successful work to protect, support, and promote breastfeeding and stem the spreading use of commercial breastmilk substitutes in developing countries are now threatened because of concern about HIV transmission in breastmilk. There is a small risk that an HIV positive woman will infect her infant through breastfeeding. However, the bigger risk is that there will be an inappropriate rush to replace breastfeeding with formula feeding by women who have HIV, or think they might have HIV, in high prevalence areas in developing countries. There may also be a large spillover of formula feeding to mothers who do not carry the virus.

HIV is particularly prevalent in sub-Saharan Africa, and ministries of health in those countries are under pressure from several sources to provide free, or subsidized, infant formula for mothers infected with HIV. It needs to be recognized that most babies with HIV were infected in *utero* or during childbirth, not through breastmilk. Indeed, there is new evidence to show that in babies who are exclusively breastfed, transmission of HIV from breastmilk was very low, at least in the first 3 months of life.

Pregnant women have a right to HIV testing and to know or not know the test results. Poor women in African countries who know they are HIV positive have a difficult infant feeding choice and need to be counseled about the risks of each option. The World Health Organisation, the UNAIDS, and UNICEF have stated that the “most effective method of preventing breastmilk transmission of HIV is breastmilk avoidance.” They have, nevertheless, recognized that when mothers do not have assured, uninterrupted access to breastmilk substitutes that can be safely prepared and fed, and “where infectious diseases and malnutrition are the primary causes of death during infancy ... then artificial feeding substantially increases children’s risk of illness and death” (UNICEF, UNAIDS and WHO 1998).

The conditions necessary for adequate and safe formula feeding unfortunately exist for only a tiny minority of HIV infected women in Africa. Mothers live in poverty and have poor access to decent health care, safe water, good hygiene, fuel, and secure supplies of breastmilk substitutes. In the end decisions need to be made on the basis of risk assessment.

Will the commercial manufacturers of breastmilk substitutes take advantage of the AIDS pandemic to peddle their products under the guise of humanitarian concern? The UN agencies agree that the *International Code of Marketing of Breastmilk Substitutes* must be respected and that no free donations of breastmilk substitutes should be provided by these corporations through the health care system. But many of the major corporations have never fully respected the Code (Latham 1999a).

In an article on the section of the *British Medical Journal* titled *Education and Debate*, Michael Latham and Elizabeth Preble discussed appropriate infant feeding practices for HIV-1 infected mothers living in poor households in sub-Saharan Africa (Latham and Preble 2000). They stated:

In many African countries, the HIV and AIDS pandemic is a major tragedy of unprecedented proportions that is increasingly affecting mothers and their children. However, even responsible health agencies have tended to exaggerate the role of breastfeeding in transmission. It is estimated that in countries with a low seroprevalence of HIV (5 % of women infected), fewer than 1 % of all infants are likely to become infected through breastfeeding, whereas in those with a high

prevalence (25 % of women infected) fewer than 4 % of infants will be affected through lengthy breastfeeding.

If preventing a child from acquiring HIV infection through breastmilk were the sole consideration, infected mothers would be advised not to breastfeed but to give their baby infant formula milk. This is the recommendation generally given to HIV infected mothers in industrialized countries, and this might be appropriate advice for many affluent mothers in non-industrialized countries. However, for infected mothers living in poor households in developing countries it is important to consider very carefully the risks related to not breastfeeding and to explore the possibility of alternative feeding methods.

The many disadvantages of artificial feeding have been widely documented, and these apply to all societies and at all levels of affluence and poverty. However, in terms of serious morbidity and mortality, the risks are much higher in poor households with inadequate sanitation, unsafe and scarce water supplies, no refrigeration, poor health services, and little knowledge of hygiene. Thus, appropriate advice on infant feeding for an affluent mother infected with HIV might be different to that given to her impoverished counterpart. Distressing though it may be to accept that advice on important health actions can be openly stated to be different for rich and poor people, the grim reality is that the world is plagued by inequity, and the gap between rich and poor people and nations is widening (Latham and Preble 2000).

In 1997 UNAIDS, WHO and UNICEF produced new guidelines on infant feeding related to HIV/AIDS which seemed like a major shift in policy, and the international press took it to mean that United Nations agencies were advising most HIV infected mothers not to breastfeed. For example, a front page article in the *New York Times* of 26 July 1998 was headed “AIDS brings shift in UN message on breastfeeding.” The article began: “Countering decades of promoting ‘breast is best’ for infant nutrition, the United Nations is issuing recommendations intended to discourage women infected with the AIDS virus from breastfeeding.”

UNICEF, UNAIDS, and WHO subsequently issued three companion documents on “HIV and infant feeding.” These laid out options in detail and tried to indicate that the organizations remained very supportive of breastfeeding. However, almost simultaneously the bodies announced that they would be conducting training courses and then trials in several African countries. As part of this work, HIV infected mothers would be offered the choice of replacing breastfeeding with formula feeding, and perhaps given other alternatives. However, mothers would always be given sufficient information to enable them to make an informed choice.

In 1998, policy makers in African governments and front line health workers, were learning—often for the first time—that HIV could be transmitted through breastmilk, but they did not know enough to be able to make informed decisions on appropriate action (UNICEF, UNAIDS and WHO 1998). The situation today is a little different, but it remains confused. We question whether it was wise to change course when so little was known about the feasibility of the different feeding options described in the UNAIDS/WHO/UNICEF guidelines and when the disadvantages and harmful outcomes of not breastfeeding still

applied, or may even have become more serious in sub-Saharan Africa because of deteriorating economies.

In the *BMJ* article, Latham and Preble (2000) state:

All the evidence suggests that mixed breast and formula feeding is the most dangerous feeding option for the young infant. It increases the risks of HIV and other infections. Regimens that support formula feeding as a way of reducing mother to child transmission of HIV need to consider the risks of non-compliance. Even in a sophisticated clinical trial in which urban Kenyan women were assigned to either breast or formula milk feeding groups, poor compliance was reported in the formula group (Nduati, John, Mbori-Ngacha, Richardson *et al.* 2000). The report's authors mention that the Nairobi women "often experienced community, family or spousal pressure to breastfeed, and were sometimes concerned about maintaining confidentiality of their HIV-1 status." Thus, it was difficult to ensure exclusive formula feeding, even in mothers who had been carefully counseled and had agreed to participate in an urban clinical trial in which formula milk was provided free. What then is the likelihood of compliance in other places where infant formula is very expensive and more difficult to obtain, piped water is not available, and very limited counseling is possible?

Greatly improved primary prevention of AIDS by means of a wide variety of interventions is an important priority in reducing rates of mother to child transmission of HIV. The availability and use of family planning for mothers infected with HIV will also reduce the number of infected children.

It is recognized that pregnant women have a right to free HIV testing and, if they are found to be positive, to proper counseling about feeding choices for their infants and the risks of each option. Unfortunately, neither of these options is available for most women in Africa. Furthermore, data on the relative risks and benefits of different feeding options are still inadequate. We do not know which option under different circumstances would save the most lives, be the least costly to society, and have the fewest negative effects.

There is clearly a need for intensified research to influence policy. Alternatives to breastfeeding, other than formula feeding, deserve more study—in particular, the feasibility of mothers expressing their milk, heat treating it, and then feeding it to their infants. Although this practice would not be easy, it is not more difficult than safe formula feeding and it provides infants with a superior food, avoids problems of access, is a locally "manufactured" product, and is low cost. More formative research on the feasibility of formula feeding and other alternatives is also necessary.

While we wait for research results, it seems that major efforts to promote exclusive breastfeeding would do great good and no harm. Exclusive breastfeeding is not widely practiced in sub-Saharan Africa, certainly not for as long as 6 months, which is desirable. Exclusive breastfeeding is clearly optimal for mothers who are not infected with HIV. For babies infected in *utero*, or during childbirth it would be the best feeding method unless the mother was too ill to do this. Furthermore, the data from South Africa suggests that HIV transmission is low in infants who are exclusively breastfed, at least for the first three months. Because the morbidity and mortality resulting from not breastfeeding are higher in the first 6 months of life than

at older ages, consideration might be given to reducing the duration of breastfeeding by infected mothers.

Answers on infant feeding practices should guide policy makers and health workers in determining the best recommendations to give mothers in areas of sub-Saharan Africa where the prevalence of HIV infection is high. This is essential, not only to minimize the risk of transmission of HIV to infants but also to minimize the high risk of morbidity, mortality, and other problems related to artificial feeding in Africa families plagued by poverty, illiteracy, and disease (Latham and Preble 2000).

These publications in the *Lancet* and *BMJ* and elsewhere, plus the long report to UNICEF on the “four country study”, helped influence current UN and national policies which now generally recommend artificial feeding by HIV positive mothers ONLY if it is AFASS, that is Acceptable, Feasible, Affordable, Safe, and Sustainable. For most mothers in Africa it is not AFASS, so breastfeeding is then recommended. Another advance is more, but still very insufficient availability of retroviral therapy for women with HIV.

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Chapter 6 - Vitamin A

Introduction

For much of the last 40 years, Michael and several of his graduate students and colleagues have been concerned with the problem of vitamin A deficiency in developing countries. Activities have included research evaluating different methods of control, investigations of the impact of vitamin A supplementation on morbidity from respiratory infections and diarrhea, and debate on the likely reasons why vitamin supplementation reduces child mortality under certain circumstances. Major studies were conducted over many years in the Philippines, in collaboration with Dr. Florentino Solon and his colleagues, in India, with Dr Ramakrishnan and Dr Abel, and more recently, in Tanzania with Dr. Ndossi.

Vitamin A is an essential nutrient for man and animals. Dietary sources of vitamin A are in two forms: preformed vitamin A from foods of animal origin and provitamin A carotenoids from plant sources, such as leafy greens, yellow fruits and vegetables, and red palm oil (Latham 1979). In the late 1970s, there was a surge of interest in, and concern for, vitamin A deficiency as a cause of blindness in many parts of the world. Florentino Solon and Michael pioneered the research looking at xerophthalmia as a public health problem of great significance and at ways to control it in the Philippines (Latham and Solon 1986).

Xerophthalmia is one of the four major nutritional problems in low-income countries. It is responsible for the death and blindness of thousands of children where the staple food contains no carotene or vitamin A. Its serious form is most frequently seen in young children between 1 and 5 years of age. Because mother's milk usually contains 100 % of the vitamin A requirements for an infant up to 6 months, breastfeeding protects against xerophthalmia in young infants.

Protein-energy malnutrition and poverty are often closely associated with xerophthalmia. Its relationship to measles has been frequently mentioned, but the mechanism for the association of the two diseases is not fully understood. Progress toward prevention has accelerated since large-scale production of chemically synthesized vitamin A began in the 1950s. In the early 1970s, fortification of suitable foods or periodic mass dosing with vitamin A made its control more feasible and at a fairly low cost. Between 1980 and 2000, major reductions in the incidence of its severe blinding form occurred in many countries world-wide, even in areas without specific control measures, for reasons that are not clear.

In the 1970s, in order to address the vitamin A problem in the Philippines, Dr. Solon and Dr. Latham developed a project first to determine the epidemiology and prevalence of vitamin A deficiency, and later to design an appropriate remedy program. Three different interventions were evaluated. The original "project in the Philippines" was carried out in 12 different locations and the three different interventions were examined in terms of efficacy, benefit-cost, and other factors of success. The results led to vitamin A fortification in multiple locations.

The project in the Philippines

In the early 1970s, Michael met with Dr. Florentino Solon to discuss the vitamin A deficiency cases that were surfacing in surveys and studies in the Philippines as well as in the newly established malnutrition wards in Cebu city (Anon 1969; Anon 1981; Anon 1983). Due to a rising interest in vitamin A deficiency and a lack of definitive data related to xerophthalmia control, Dr Solon and the Cebu Institute of Medicine, as well as Michael and the program in International Nutrition of Cornell University, wrote grant proposals to address the issue and received funding from WHO, the Philippine National Science Development Board, and USAID. The original project in the Philippines was later expanded with work in provinces beyond Cebu. In Cebu, Dr. Tom Fernandez at the Cebu Institute of Medicine was a close collaborator. Dr Solon, Michael, and fellow Cornell University faculty, as well as several graduate students (including Juan Aguilar, Barry Popkin, David Williamson and Heather Warrack), worked together to address resulting issues such as blindness, morbidity, and mortality in several other countries.

In order to determine the prevalence of xerophthalmia in Cebu and its association with several other nutrition and health factors, a four stage plan was designed as follows:

- (1) identification of the extent of the problem and examination of factors involved in its aetiology;
- (2) evaluation of alternative strategies to control it in different communities.
- (3) field trial in several provinces to examine the feasibility and effectiveness of one control method;
- (4) implementation of a national control program.

At that time, it was unusual to carry out these three logical steps before considering a national public health program, and this was the first, and perhaps only time, that the relative efficacy of three control methods was field tested.

The first phase was conducted from July to September 1973, as the first stage of a 3 year pilot project. It was designed to examine the epidemiologic, clinical, and biochemical differences in four ecological zones in Cebu, namely: 1) urban slum or squatter areas, 2) urban fringe barrios, 3) rural coastal barrios, and 4) rural hinterland semi-mountainous barrios. Each zone represented a place where differences were perceived in diet, market accessibility, sanitary conditions, occupations, etc, all of which may be expected to relate to health problems, including xerophthalmia.

For the purposes of this study, xerophthalmia was defined as the combination of both a deficient or low serum vitamin A level and the presence of clinical signs of xerophthalmia. The clinical signs used were those adopted at a joint WHO/USAID meeting held in Jakarta, Indonesia in 1974 where both Michael and Dr Solon participated. They included conjunctival xerosis, Bitot spots, corneal xerosis, keratomalacia, night blindness, xerophthalmia fundus, corneal scars, and any combination of these.

The baseline measurements of 1715 children indicated a high prevalence of both ocular signs of xerophthalmia and low serum vitamin A levels (Solon, Popkin, Fernandez and Latham 1978). This claim was supported by clinical and biochemical data as well low

dietary intake of vitamin A. Xerophthalmia was very prevalent in children of all ages. Previous findings had indicated that protein intake may be related to vitamin A status and fat intake to xerophthalmia. Although low vitamin A intake was associated with a higher probability of xerophthalmia, no relationship was observed between protein intake and vitamin A status, nor between fat intake and xerophthalmia. A new and interesting finding was that xerophthalmia occurred significantly more in children whose mother had employment outside of the home, even though this resulted in a higher mean family income. The lower intake of vitamin A in these children was likely because the presence of the mother at meal times is important if young children are to consume vegetables. Income itself was not a particularly important factor. The prevalence was higher in boys than in girls and this difference increased with age. Having tuberculosis was positively correlated with xerophthalmia, whereas recent diarrhea, measles, and roundworm were not.

The results of this research in Cebu were used to develop stage two of the three phase project: planning and implementation of three different intervention strategies to assess their relative efficacy. At the time, this represented one of the few studies in the nutrition area which had attempted to conduct a benefit-cost analysis to aid in public policy determination of the use of nutrition resources (Solon, Fernandez, Latham and Popkin 1979).

The three strategies used in the six rural and six urban settings were public health and horticulture (PH); high dose vitamin A capsules (HDC); and fortification of monosodium glutamate (MSG) with vitamin A. The capsules program consisted of a mass dosage capsule of 200,000 IU of vitamin A given every 6 months to children. The PH used paraprofessionals plus village volunteers to carry out horticultural activities, health and nutrition education, disease prevention (sanitation, immunization), and limited curative work. The MSG was fortified with 15,000 IU of vitamin A in each 2.2 g packet; a family of six uses an average of two packets per day.

A dietary intake analysis was conducted and the most frequently consumed items were table salt, MSG, and flour-based products. Unlike salt and flour which were produced by a large number of firms, 95 % of the MSG in the country - most widely used as a flavor enhancer - was then produced by one manufacturer. It was thus selected for fortification. This was a pioneering venture because MSG had never before been used for fortification. A detailed study was conducted 4 months after the baseline study in order to determine the marketing and consumption patterns of the population. Based on its results, and in consultation with scientists at Hoffmann-LaRoche in Nutley, New Jersey, it was decided to include 15,000 IU vitamin A in each 2.2 g MSG packet. Extensive tests were carried out on the product to determine storage capability at different temperatures and duration. Questions related to toxicity were very thoroughly reviewed. For this pilot project, fortified packets of MSG were prepared and distributed to the families on a regular basis. The results indicated encouraging prospects for vitamin A fortification. At that time, the cost of fortified MSG to the consumer and to the government was not more than the cost of non-fortified MSG.

A total of about 1800 children were selected using a stratified random sampling technique. The *barangays* were characterized by poor sanitation and water supplies, low level of parental education, and inadequate health services. Mainly for ethical and humanitarian reasons, the investigators were adamant in their decision not to include a control group of areas that received no intervention. Although the lack of a control or

placebo group inevitably weakens the conclusions that can be drawn, the purpose of the study was to determine the relative efficacy of three different interventions and their costs, and to allow recommendations to be made for the national control program. Considering this objective, such an approach with no control group is often justified.

All three programs provided excellent protection against blindness and the clinical signs of xerophthalmia decreased in all groups; significant at the 0.01 % level for HDC and MSG, but not for PH. The mean serum vitamin A levels rose significantly ($p < 0.01$) in the MSG group, but no increase was recorded in the other two groups. This highly significant change indicates that subjects at greatest risk because of a deficient intake, or low serum levels, generally benefit the most from fortification of MSG with vitamin A. When comparing the overall benefit-cost ratios, both the HDC and the MSG programs produced significant net benefits, while PH's costs were greater than its benefits. Based strictly on income criteria and the objective to eliminate xerophthalmia, the MSG fortification program was recommended by the authors. However it was recognized that the HDC and MSG interventions could only improve vitamin A status, whereas the PH intervention could benefit PEM, other micronutrient deficiencies, as well as general health (Solon, Popkin, Fernandez and Latham 1978).

The work described above showed (a) that a serious problem of vitamin A deficiency and xerophthalmia existed, and (b) that fortification of MSG with vitamin A was the most effective and the least costly of three interventions. After many extensive discussions in the Philippines with scientific and health professionals, government officials, and with those involved in national nutrition policy, a 'real life' trial of MSG fortification was undertaken in two provinces with a third province serving as a control.

After overcoming multiple roadblocks set by manufacturers, doctors, and other adversaries, the MSG fortification intervention moved ahead. In 1979, baseline data, including eye examination and serum retinol levels, was collected from children in each of the three provinces. A few months later, the small packets of MSG going to Neuva Vizcaya and Marinduque were fortified in the factory in Manila and distributed. After approximately 20 months, follow-up surveys and examinations were carried out showing a significant reduction in eye signs of xerophthalmia in both intervention provinces, while in the control province of Cebu the prevalence rose from 2.1 to 3.2 %. Mean serum retinol levels rose from 27.7 to 31.2 $\mu\text{g} \%$ ($p < 0.01$) in Marinduque and a less significant rise occurred in Nueva Vizcaya (31.0 to 32.1 $\mu\text{g} \%$; $p < 0.05$), as well as in Cebu, the control province (29.4 to 30.8 $\mu\text{g} \%$; $p < 0.05$). Perhaps more important, there was a dramatic decrease in the percentage of children with serum retinol levels below 20 $\mu\text{g} \%$. In the two intervention provinces, the decrease was significant at 0.01 %, but in Cebu, the control province, the decrease was only significant at 0.05 %. The rise in serum retinol levels in Cebu was likely due to improvements in health, nutritional status, and living standards of the urban poor. Dr. Solon had then become mayor and had introduced many benefits (Solon, Latham, Guirriec, Florentino *et al.* 1985).

From this study in three provinces, it was concluded that fortified MSG was well accepted by consumers and improved vitamin A nutritional status. At the time, there was no universally acceptable method of control appropriate to all areas where the problem was

serious (Sommer, McLaren and Olson 1976). Each community or country had to choose the measure that seemed best suited for that area and for the people living there.

It had been predicted that in the long term, the control of vitamin A deficiency could be improved by decreasing poverty, improving health services, increasing the availability and consumption of foods rich in vitamin A and carotene, and improving horticultural activities (Latham and Solon 1986). As a result of the Philippines project, it seemed that food fortification offered the best hope to reduce vitamin A deficiency in the short and long term. This method had many advantages and it was the cheapest and most effective intervention. However, before a national program of MSG fortification could be recommended, a small number of technical and operational problems needed to be resolved. The technical problems included variability in vitamin A content due to the production process, loss of vitamin A potency due to temperature and humidity during prolonged field storage, and physical changes, namely, color change and hardening. These were seen to be within the grasp of the technologists. There were also operational, political, and other considerations associated with the implementation of such a program, including support from the government, the manufacturers, the scientific community, and the public. In 1980, the US Food and Drug Administration, along with the WHO and FAO, decided that MSG was safe; however it was still widely considered to be toxic. The social health benefits of fortification needed to be weighed against the “adulteration” of a product or the expressed fear of toxicity. In the end, judgment about control had to be made by Filipinos for Filipinos. Those making a final decision should appreciate that xerophthalmia is often a devastating disease resulting in high case fatality rates and often a life of permanent darkness for those who survive.

This project provides a good case of true collaboration where mutual trust, a sharing of work, and joint funding contributed to a successful outcome (Latham and Solon 1986).

Impact of vitamin A on growth in children

When examining the impact of vitamin A supplementation on morbidity in children in both the Tanzania and India studies, good anthropometric data was also collected. In neither case were there significant differences in weight or height gains between the vitamin A supplemented and the control children. In the India study, these differences in weight and height gain remained unaltered following multivariate analysis, suggesting the lack of an effect of vitamin A supplementation on growth of children where access to health care and immunization are good (Ramakrishnan, Latham and Abel 1994).

A decade later in Tanzania, the impact of a multiple micronutrient dietary supplement was evaluated (Ash, Tatala, Frongillo, Ndossi *et al.* 2003). This was a randomized, double-blind efficacy trial with 774 school children 6-11 years of age. Those receiving the supplement had significantly greater increases in both weight and height than those receiving the placebo. However, the purpose of the study was to examine the possible benefits of a multiple micronutrient supplement, not of vitamin A. So it cannot be concluded that the vitamin A did, or did not, contribute to this improved growth. It is quite possible that one or more of the micronutrients had an impact on growth. A possible candidate is iron which, in previous studies, we have shown improves appetite.

Vitamin A and breastfeeding

Despite recommendations that mothers breastfeed for 2 years and beyond, little is published regarding the contribution of breastmilk to vitamin A intakes in children. In a study conducted in Tamil Nadu in South India to address this issue, the vitamin A intake of children aged 1-3 years was assessed using a quantitative food frequency questionnaire. Trained field workers interviewed mothers about their children's usual consumption of common sources of vitamin A and collected information on portion sizes using standard cups. Vitamin A intakes from sources other than breastmilk were extremely low at all ages. Maternal education and socioeconomic status (SES) were positively associated with total vitamin A and retinol intakes. Girls had significantly lower intakes than boys, even after adjusting for differences in age, maternal education, SES and breastfeeding status. Children who were not breastfed met only 60 % of the Indian recommended dietary allowance (RDA), whereas those who were, met approximately 90 % of the RDA during the second year of life. The findings of this study support the importance of breastmilk as a major source of preformed retinol for young children (Ramakrishnan, Martorell, Latham and Abel 1999).

When evaluating the impact of a multiple micronutrient dietary supplement in pregnant and lactating women in Tanzania, we examined the retinol content of breastmilk (Latham, Ash, Makola, Tatala *et al.* 2003). This was a double-blind, placebo controlled efficacy trial. Approximately 4 weeks postpartum, samples of breastmilk were obtained from 50 mothers in the supplemented group and 34 in the placebo group. The mean retinol level of the breastmilk in the supplemented group was 1.24 $\mu\text{mol/L}$ compared with 1.06 $\mu\text{mol/L}$ in the placebo group, a highly significant difference. Serum and breastmilk retinol levels were also positively correlated, though they were not associated with other measures of nutritional status such as hemoglobin and serum ferritin levels.

From these and other studies, and from the rather thin research literature on this topic, we conclude that the importance of breastfeeding for the vitamin A status of children 6 – 36 months old, has been neglected, especially the importance of long duration breastfeeding. Supplementing pregnant and lactating women with vitamin A may be important, along with the usual iron and folic acid supplements.

Vitamin A - it's role in child mortality and morbidity

In 1984, while governments and international agencies were giving increased attention to the magnitude of xerophthalmia and to the means available for dealing with it, Michael drew attention to the lack of knowledge concerning the relationship between measles and xerophthalmia. In particular, he wanted to explore the possibility that blindness following measles was due mainly to vitamin A deficiency, as reports coming from Africa were showing (Latham 1984). Sommer had just completed a detailed study which suggested the importance of vitamin A in childhood mortality and advanced the understanding of the clinical and pathological aspects of its deficiency (Sommer 1981).

The Philippines study was then in its third stage, with MSG fortification being carried out in three provinces. Indonesia, influenced by the experience in the Philippines, was seriously considering fortification of MSG with vitamin A (Latham and Solon 1986). India had the most extensive experience with the use of periodic dosing of children having

implemented a national vitamin A prophylaxis program in the early 1970s. In 1984, it covered over 50 million children. Unlike many other countries that used high dose capsules, India used a locally manufactured liquid formula, which evaluations had found to be effective, but not without problems.

These studies laid the foundation to make recommendations for the control of xerophthalmia. It was considered that in most countries, if an appropriate vehicle could be found, fortification was the cheapest and most effective means of controlling xerophthalmia. High dose capsules required an expensive delivery system and called for locating all children at risk every 6 months, leaving vulnerable children the most at risk of being missed. For the short-term, fortification and high dose capsules were thought to be the most beneficial treatments. However, in the long run, horticultural practices that increase the availability of nutrient rich foods, the provision of health services and nutrition education, and steps to reduce poverty, were seen as the most effective course of action (Latham 1984).

Around that time, an important study in Indonesia showed that low intakes of vitamin A, even in those without clinical signs of xerophthalmia, were associated with increased mortality (Sommer, Djunaedi, Loeden, Tarwotjo *et al.* 1986). Soon after, two important studies clearly showed the link between vitamin A deficiency and measles: one in Tanzania and one in South Africa. A randomized clinical trial in Tanzania showed a marked reduction in fatality rates in children with measles receiving vitamin A supplements (Barclay, Foster and Sommer 1987). In South Africa, the benefits of providing vitamin A to children with measles were again shown, including greatly reduced morbidity and mortality (Hussey and Klein 1990).

In 1992, Beaton, Martorell, Aronson, Edmonston, McCabe, Ross and Harvey (1993) conducted a meta-analysis examining the effect of vitamin A supplementation on childhood morbidity and mortality in developing countries. They presented evidence for the claim that vitamin A supplementation reduces mortality rates in young children by around 30 %. They also drew attention to the fact that the course of the episode and the case fatality rate of measles may improve with vitamin A supplementation. The analysis was based on eight studies, all of which were designed to determine the impact of high dose vitamin A medicinal supplementation on childhood mortality in young children. Six of these showed significant reductions in mortality. Two of these eight studies, namely the Harvard University study in the Sudan and another study in India, showed no significant reduction in childhood mortality. Overall, the authors concluded that vitamin A supplementation reduced childhood mortality by 20-30 %. This categorical statement on mortality is what caught world attention, more than the caveat that the analysis found no impact of the vitamin A supplementation on childhood morbidity, except from measles.

Most persons in the nutrition community, including in WHO, UNICEF, and many NGOs such as HKI, as well as in a host of developing countries, are supportive of programs to provide regular high dose vitamin A supplements to young children. If asked why they support and fund these programs, most would answer that this will prevent xerophthalmia, but more importantly that this has been clearly shown to reduce young child mortality by 20 to 30 %. Current evidence, although seldom discussed in detail, suggests that worldwide, the incidence of serious cases of xerophthalmia and blinding keratomalacia has declined markedly, even where vitamin A supplements are not regularly provided. This seems to be

the case even in Asian countries where xerophthalmia was prevalent in previous decades and despite surveys showing a moderate prevalence of low serum retinol levels. The six studies in the meta-analysis showing significant reductions in child mortality (and two studies showing no reduction) were completed over 15 years ago. In almost all of them, vitamin A deficiency was prevalent in the population of children enrolled, malnutrition was extensive, a high proportion had not been immunized against measles, and in some cases they received rather minimal levels of health care during the studies. For ethical reasons, a double-blind placebo controlled mortality study in children should probably never be done again.

Despite the convincing evidence that vitamin A supplementation - usually using periodic high doses of vitamin A - significantly reduced child mortality (Beaton, Martorell, Aronson, Edmonston *et al.* 1993), some of us were critical of the studies and their conclusions (see also *addendum* to the chapter), but accepted the results. The conclusion was that vitamin A supplementation was reducing deaths due to diarrhea and respiratory infections, the two leading causes of child deaths in these countries. According to WHO, diarrhea contributes to 32 % of child mortality in developing countries, and respiratory infection to 36 % (for a total of 68 %). The obvious question then was, to what extent did vitamin A supplementation reduce morbidity from each of these separately? or if medicinal high dose vitamin A supplements reduce child mortality by 20-30 %, then to what extent is this due to reduction in morbidity from diarrhea and respiratory infection (other than measles). The Cornell group thus proceeded to study this in Tanzania (Ndossi, Latham, Roe, Miller *et al.* 1993) and in India (Ramakrishnan, Latham, Abel and Frongillo 1995). Both studies showed no significant difference in morbidity from diarrhea or respiratory infections in those receiving vitamin A compared with a control group receiving a placebo. In both studies, we excluded and treated severely malnourished children, assured that all study subjects had been immunized (including against measles), and that for the duration of the study, children had good access to reasonable health care. These conditions were not all present in the eight mortality studies of the meta-analysis.

The Tanzania study, a part of which constituted the Ph.D. dissertation of Godwin Ndossi, was first reported on at the XVth IVACG meeting in 1993. The abstract summarizes the research and findings:

A double-blind study was conducted in Iringa, Tanzania to assess the impact of a single dose of vitamin A (VA) on child growth and morbidity.

Pre-school children were randomized to receive VA (n = 277) or placebo (PL) capsules (n = 277), and followed for approximately 8 months. Both groups were comparable at baseline in terms of age and sex distribution, immunization coverage, nutritional status (NS), and maternal demographic characteristics. Mild to moderate malnutrition was prevalent among children in both groups and the mean serum retinol level was 17.37 µg/dL. No children had active signs of xerophthalmia. Following supplementation, children in the VA group had higher but non-significant mean percent weight-for-height (W/H) throughout the study. Reported morbidity from respiratory disease, fever, malaria, skin infections, and intestinal parasites showed a strong seasonal variation and was not markedly reduced through VA consumption.

We suggest that for children without severe malnutrition, without eye signs of xerophthalmia, and those immunized against measles, etc., high VA capsules are not recommended. Instead, other measures such as fortification, horticulture, deworming and control of infections should take higher priority (Ndossi, Latham, Roe, Miller *et al.* 1993).

The study in Tamil Nadu, India, was conducted in the same villages where we had investigated the benefits of growth monitoring. The research formed the basis for the Ph.D. dissertation of Usha Ramakrishnan. Several publications emanated from her research. The paper dealing with the impact of vitamin A supplementation on child morbidity is summarized in this abstract (Ramakrishnan, Latham, Abel and Frongillo 1995).

A randomized, double-blind, placebo-controlled trial was conducted in an ongoing Growth Monitoring Research project in Tamil Nadu, India, to assess the impact of high-dose vitamin A supplementation on morbidity among mildly to moderately malnourished children aged < 3 y. Every 4 mo, the treatment group received 60 mg vitamin A (200 000 IU) whereas the control group received a placebo. Cases of xerophthalmia and severe malnutrition were excluded. Anthropometric measurements and serum retinol determinations were made at baseline and at the end of 1 y. Morbidity data were collected by trained village-level workers throughout the study period by using the weekly recall method. The two groups had similar nutritional status, serum retinol concentrations, age-sex composition, and other socio-demographic indicators at baseline. The mean number of episodes per child-year was 2.62 ± 2.95 and 2.56 ± 2.5 for respiratory illness and 1.9 ± 2.2 and 1.77 ± 1.77 for diarrhea for the vitamin A (n = 309) and placebo (n = 274) groups, respectively. The differences in respiratory and diarrheal morbidity between the two groups were not statistically significant and these findings remained unaltered after multivariate analysis in which the effects of age, sex, socioeconomic status, sanitation, etc, were considered. These findings are similar to other recent findings and indicate that vitamin A supplementation does not reduce common morbidity in children with mild-to-moderate vitamin A deficiency in areas where access to health care and immunization are good (Ramakrishnan, Latham, Abel and Frongillo 1995).

It is important to note that, unlike in the eight mortality studies of the meta-analysis, the children included in our studies in Tanzania and India had received measles (and other) immunizations. We also did not include seriously malnourished children and we provided good health care to all study children. Concurrent with, and subsequent to these two Cornell studies, there have been more than 12 good investigations which also have shown no reduction in diarrhea or respiratory infection morbidity resulting from vitamin A supplementation when compared with a placebo group, or a control. Several of these other studies actually showed a modest, but significant, increase of respiratory symptoms in those receiving vitamin A supplements. It seems worth summarizing the findings from some of these other studies.

A double blind randomized placebo controlled field trial in New Delhi in India was conducted to assess the impact of vitamin A supplementation on "morbidity from acute respiratory tract infections and diarrhea" on 900 children aged 9-60 months (Bhandari, Bhan and Sazawal 1994). The conclusions were: "The study found the incidence and average number of days with acute lower respiratory tract infections to be similar in both groups. The

incidence of diarrhea was also similar.” The paper goes on to state that “the incidence of measles was significantly reduced in the vitamin A supplemented group” when compared with those children receiving a placebo.

An earlier very large study in India had also shown no impact of vitamin A supplementation on morbidity from diarrhea or respiratory infections (Rahmathullah, Underwood, Thulasiraj and Milton 1991). This study included 15,419 children aged 6-60 months, and was a placebo-controlled masked clinical trial. Half of the children received weekly doses of 2500 µg of vitamin A and 20 mg of vitamin C, and half received only 20 mg of vitamin C. At weekly examinations, the mothers’ recall of daily morbidity for the previous 7 days, was recorded. At baseline 72 % of children had “undernutrition” and 11 % had xerophthalmia. Weekly supplementation with vitamin A did not influence the incidence, severity, nor duration, of diarrhea or respiratory infections.

One of the more recent studies was conducted in Mexico to evaluate the impact of vitamin A and zinc supplementation on overall rates of childhood diarrheal disease and respiratory tract infections (Long, Montoya, Hertzmark, Santos *et al.* 2006). It was a double blind, randomized placebo controlled trial with 736 children aged 6-15 months in peri-urban Mexico City. The subjects were assigned randomly to one of four groups namely (a) vitamin A every 2 months, (b) zinc daily, (c) vitamin A and zinc, and (d) placebo. The children were followed for 12 months. Vitamin A supplementation in the four-group analysis was associated with a 27 % increase in diarrheal disease and a 23 % increase in cough with fever. Zinc decreased diarrhea in children under some circumstances. The authors concluded “vitamin A increases diarrheal disease and respiratory tract infections in young children in peri-urban Mexico City”.

A WHO/CHD multi-country study published in the *Lancet*, looked at 9,424 mother infant pairs in Ghana, India and Peru (WHO/CHD Immunisation-Linked Vitamin A Supplementation Study Group 1998). At times of standard immunizations, 50 % of mothers received 200,000 IU of vitamin A and their children received 25,000 IU. The 50 % in the control group received immunizations without vitamin A supplements. The conclusion was that the vitamin A intervention “had no effect on anthropometric status, or on overall, or severe, morbidity”.

In Indonesia, Semba, Munasir, Beeler, Akib, Muhilal, Audet and Sommer (1995) evaluated the effect of simultaneous vitamin A supplementation on the immune response to measles immunization at 6 months of age. This was a randomized double blind placebo controlled clinical trial. It was found that “vitamin A administration reduced the likelihood of seroconversion to measles (after controlling for maternal antibody titers)”. The authors concluded “these results suggest that simultaneous high-dose vitamin A may thwart seroconversion to live measles vaccine in infants with maternal antibodies”. This is a troubling finding.

Related to this, the 2008 *Lancet* Series states “Vitamin A did not affect morbidity from infectious diseases” (Bhutta, Ahmed, Blake, Cousens *et al.* 2008). It should also be recalled that the Beaton report stated “In contrast to the very clear effect of vitamin A on mortality, we were forced to conclude that improvement of vitamin A status cannot be expected to impact on incidence, duration or prevalence of diarrheal and respiratory

infections” (Beaton, Martorell, Aronson, Edmonston *et al.* 1993). The Beaton paper went on to state “one aspect of the morbidity analysis that has direct relevance to field programs was the fact that vitamin A intervention after the onset of measles impacted favorably upon the development of severe complications and reduced the case fatality rate”.

Thus, reviews of these vitamin A supplementation studies in two African and several Asian countries, showed no impact on morbidity from diarrhea or respiratory infections, but markedly reduced the severity of the illness in measles, and lowered case fatality rates. Should we not be more concerned than seems to be the case that several well-conducted studies have shown that vitamin A supplements provided to young children have actually increased the incidence or prevalence of respiratory infections.

The very clear evidence that vitamin A given to children greatly reduces both morbidity and mortality in measles seems relatively ignored. The important question is whether greater efforts should not be placed on universal immunization against measles, which could eventually lead to total world eradication of this important, sometimes fatal disease. This is feasible (Latham 2008). If resources are limited (which they surely are) should not some of the funds, and resources, now devoted to providing vitamin A supplements to children in areas where xerophthalmia is not prevalent, be used to devote increased efforts for child immunizations, especially against measles ?

Addendum – the vitamin A mortality studies

Michael, and several of his colleagues at Cornell, have raised questions regarding certain of the vitamin A mortality studies, and concerning the rapid move to vastly expand high dose vitamin A supplements, almost as a magic bullet to reduce childhood mortality. These questions were usually raised in the journals in which the mortality results were published, namely the *Lancet* and the *New England Journal of Medicine*.

Some examples follow. In referring to the important Indonesian study showing a major reduction in childhood mortality from periodic high dose vitamin A supplements (Sommer, Djunaedi, Loeden, Tarwotjo *et al.* 1986), we wrote in the *Lancet* (Martinez, Shekar and Latham 1986):

It is not clear how randomization was done, or why it was done in part at the time of the baseline examination and in part later. No placebos were used, and the influence of providing treatment to some and not to others needs to be recognized. Despite randomization, clinical signs of vitamin A deficiency, a recent history of diarrhea, and poor growth were all commoner in the control than in the treatment group at baseline. Were general welfare and health conditions worse in the control than in the study villages and might these differences, rather than vitamin A supplementation, explain the difference in childhood deaths?

The recall methods used are subject to under-reporting and the method used to assess vitamin A distribution is also subject to error.

The anthropometric measurements reported were taken on a 10 % sub-sample (presumably at random). Why was weight-for-age not reported? Weight-for-age provides a better predictor of one-year mortality than either height-for-age or weight-for-height. The programme villages had 32.1 % while the control villages

had 36.5 % of children below 90 % height-for-age. This apparent difference is important because children with growth deficits are probably at greater risk both of vitamin A deficiency and death.

The units of randomization are villages but the data are presented for the sampling units (children). It would have been preferable to present analysis-of-variance tables with nested error structures for the whole and subunit factors.

The 34 % reduction in pre-school mortality is presented in terms of relative risks, but since the question of interest is the public health impact of vitamin A prophylaxis on mortality, it would have been preferable to estimate attributable risks.

We went on to state:

No information is given on causes of death. Evidence of reduced susceptibility to infectious diseases subsequent to vitamin A supplementation would add to the biological plausibility of the impact.

Although the protocol was reviewed by a steering committee there is no mention of informed consent from the parents or the village community leaders. Why were so many infants given vitamin supplements when this practice was proscribed by the Indonesian government? Withholding vitamin A supplements from over 10,000 controls raises ethical questions since earlier Indonesian research by the same group had claimed that morbidity and mortality were significantly related to vitamin A deficiency and were reduced by supplementation. Alternative designs would be a sequential trial with a built-in surveillance system that would allow the study to be terminated when differences reach significance; or the provision of some other public health intervention such as immunization in both the control and study villages.

This Indonesian study will, as suggested in your editorial, stimulate more research on the relation between vitamin A deficiency and childhood morbidity and mortality. In countries where vitamin A deficiency is an important cause of blindness, a high priority should be given to the control of xerophthalmia, and measures include greater production and consumption of carotene and vitamin A rich foods, fortification of foods, and regular vitamin A dosing of young children. But until the questions raised by us and others are resolved, it would be premature to rush to action with vitamin A dosing in the belief that this will reduce childhood mortality in those with mild vitamin A deficiencies (Martinez, Shekar and Latham 1986).

After the Indonesian research the next most influential study showing a reduction in child mortality due to vitamin A supplementation was that done in India (Rahmathullah, Underwood, Thulasiraj, Milton *et al.* 1990). Their results helped stimulate a rush to the wide use of non-physiological high dose vitamin A supplements to whole populations. We raised a note of caution stating that the problem is how best to ensure increased intakes of carotene and vitamin A to children at risk. This may be achieved by fortifying a suitable food and preferably in conjunction with better health care, nutrition education and horticultural activities to increase the availability of carotene-rich foods (Latham and Habicht 1991).

We went on to write in the *New England Journal of Medicine*:

The provision of medicinal vitamin supplements for large populations through either massive doses every 6 months, or weekly physiological doses, will often require a very costly delivery system, may lead to decreasing participation over time, and may not reach many of the poorest families whose children are at greatest risk. We are not opposed to the provision of large dose supplements of vitamin A to children at risk – for example, when they come in contact with the existing primary health care system, at the time of immunization, during visits to monitor growth, and especially during treatment for illnesses such as measles. However, we are concerned about the institution of large national programs to provide daily or weekly supplements of synthetic vitamin A to children at risk. Such efforts are unlikely to be sustainable and will divert scarce resources from other health and nutrition intervention programs. We fear that the dramatic findings in the Tamil Nadu study may lead to strong advocacy of this approach, perhaps by the international agencies with support from the pharmaceutical industry. The frequent consumption of vitamin A supplements in pills, capsules, or liquids may be advisable for some more affluent families, in certain institutions, or even in refugee camps, but it should not be recommended for large programs addressing the needs of the millions of poor infants and children in developing countries.

Our major worry is that governments and international agencies may, as a result of recent research, only use vitamin A supplementation programs as a magic bullet to reduce childhood mortality, divorcing such programs from other efforts to improve nutrition and reduce morbidity. We cannot afford to ignore the underlying causes of malnutrition and infections, which may include poverty and associated inadequate diets, unsatisfactory sanitation and water supplies, and uncontrolled infections. Attractive-sounding and well-motivated programs that are not sustainable must be avoided (Latham and Habicht 1991).

Only two vitamin A mortality studies were conducted in Africa. The first was by the Harvard University group in the Sudan (Herrera, Nestel, el Amin, Fawzi *et al.* 1992). No difference in child mortality was observed between children receiving vitamin A compared with those not receiving it. The second study was conducted in Ghana on a very large population of children (Ghana VAST Study Team, Ross, Dollimore, Smith *et al.* 1993). There were 88 fewer deaths in the control population of children than in the vitamin A supplemented children. Though not large, this was a highly significant difference. A piece in the *Lancet* (Latham 1993) examined the findings and raised the still relevant question of whether the difference in mortality might be due to measles.

The Ghana vitamin A supplementation trial supports the findings of several studies in Asia that have shown similar reductions in child mortality associated with vitamin A supplementation. By contrast, almost all studies of vitamin A supplementation on morbidity have shown no differences in prevalence of diarrhea and respiratory infections (the major causes of childhood deaths in developing countries) between children receiving vitamin A or placebo. Measles is the one cause of childhood morbidity in which it has been clearly shown that vitamin A supplements reduce the severity of illness and case-fatality rates. Could it be that in the Ghana study, and perhaps also the Asian studies, the reductions in mortality rates were due mainly to a reduction in death from measles?

This question cannot be definitively answered because the cause of death was not accurately established. In the Ghana and other trials, the cause of death was

established by “verbal autopsy” (a wonderful oxymoron): a field worker, usually months after the child died, questioned parents and others about events preceding the child’s death, including symptoms. This information was then reviewed by three physicians who assigned the cause of death to one of 11 categories. I think these “causes of death” are suspect, and suggest deaths recorded as due to “malaria” or “gastroenteritis” (23 % and 26 % of the deaths, respectively) were probably deaths in which pyrexia and diarrhea were presenting symptoms. Since malaria cannot be definitively diagnosed without identifying plasmodia in blood, could some of these deaths preceded by fever and diarrhea have been due to measles before the rash? Measles often presents with high temperature and diarrhea, and is difficult, even for a physician, to diagnose in the days before the rash. There is clear evidence that providing vitamin A supplements to children with measles dramatically reduces fatality rates. Such data do not exist for gastrointestinal or respiratory infections. If this is so, there are important policy implications. Vitamin A supplements every 4 to 6 months are again being proposed as a “magic bullet” and a highly cost-effective way of reducing child mortality, a strategy I consider inappropriate and unsustainable. There are also strong moves to include vitamin A dosing as part of immunization programmes. Surely a much higher priority should be placed on efforts to assure a widespread coverage of measles immunization. In the Ghana study, the 20 % of deaths due to measles could have been prevented by immunization without vitamin A supplements. I suggest also that most of the other deaths claimed to be prevented by vitamin A could also have been prevented by immunization (Latham 1993).

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Chapter 7 - Anemia

The first paper Michael ever published dealt with anemia. It was in 1959. He was then a young MD in charge of the Hospital and District Health Services in Songea, Tanzania. It was the era when protein deficiency was considered a major cause of malnutrition. Michael designed a study to investigate, in school children, the relative efficacy of four interventions compared with a control (Latham 1960). Interestingly, one of his most recent of the over 400 publications in this bibliography, published in 2007, was also on anemia and again from research done in Tanzania. This was a report presented at the Micronutrient forum in Istanbul, Turkey, dealing with the comprehensive research and action program aimed to reduce anemia in the whole population on Chole Island (Ash, Tatala and Latham 2007).

In the years between 1960 and 2007 Michael, and the many others working with him, several for their Ph.D. dissertations, investigated various aspects of anemia. These studies covered everything from the impact of helminthic infections in Kenya, to descriptive and related studies in Guyana, Liberia, and Jamaica; to the impact of iron supplementation on appetite and growth in children; and to clinical trials of the impact of multiple micronutrient supplements (including iron and folate) on iron status in children and in pregnant women in Tanzania. Today, anemia remains the most prevalent, important, and intractable of the micronutrient deficiencies worldwide.

Protein and anemia

Recognizing the many different causes of anemia in tropical countries, Michael conducted a first study in children in Tanzania in 1959 to examine the relative efficacy of four interventions, compared with a placebo. These were iron supplementation with ferrous sulphate; malaria prophylaxis with chloroquine; treatment of hookworm with an anthelmintic; a daily dietary supplement of dry skim milk and meat powder named *nyamaziwa*; and a placebo. Michael concluded that those receiving the protein-rich supplement improved their hemoglobin level more than did the others. His assumption that this was because of the extra protein may have some basis, but may also be fallacious. In 1960, not a lot was known about the importance of heme iron. Today, we know that even the relatively small amount of iron in the milk-meat powder was likely responsible for the greater improvement of hemoglobin in this group of children compared to the others (Latham 1960).

Almost 50 years later, dietary iron deficiency (including insufficient heme iron), malaria, hookworm, and low intakes of animal protein are still important causes of anemia in the tropics. In most settings in Africa, Asia, and Latin America the relative importance of each has not been exactly determined. The role of animal protein in preventing anemia is still not clear.

Geographic anemia studies

Worker productivity in Kenya

In the late 1970s, the full effects of nutrition and health on worker productivity were as yet unclear. In 1976 the World Bank in Washington, DC, funded, and to some extent commissioned researchers to investigate the relationship of nutrition and health factors to work capacity in Kenyan road workers (Brooks, Latham and Crompton 1979). The Bank was supporting a major project to construct rural access roads using labor intensive methods and a minimum of mechanization. The research was to investigate the extent to which nutrition and health factors contributed to low worker productivity. Workers from two regions of Kenya, the Nyeri and Kwale Districts, and from two sites in each district, were recruited. In all, 102 male road workers in Nyeri and 179 in Kwale participated. At the beginning of the study, approximately equal proportions (38 % in Nyeri and 41 % in Kwale) had weight-for-height below 85 % of the standard. However, none of the men in Nyeri had hemoglobin below 13 g/dl, while 34 % of those in Kwale did. Also, the mean hemoglobin in Nyeri was 15.4 g/dl but only 12.9 g/dl in Kwale. Anemia was prevalent in Kwale but hardly seen in adult male workers in Nyeri (Brooks, Latham and Crompton 1979).

Two supplementation studies were conducted. In the first one, about 700 additional Calories were provided daily for 4 weeks to each worker at both sites in Nyeri and only one site in Kwale. Even with the short timeframe, the extra energy prevented weight loss that otherwise would have occurred in most men, and promoted minor weight gain. This suggested that increasing energy intake over a longer time period could improve the workers' weight-for-height ratios, in turn improving their work capacity.

The final group in Kwale received iron supplementation in lieu of the extra energy. Six hundred milligrams of ferrous sulphate were provided each day to the men who came to work. The other workers received 50 mg of ascorbic acid each day. Since the latter may increase iron absorption, the study did not have a true control group. However, those receiving iron had a rise in hemoglobin of 1.23 g/dl, while those getting vitamin C only saw an increase of 0.11 g/dl.

In subsequent research between February 1978 and March 1980, male road workers in various rural areas of the country were again recruited, enrolled, and monitored. The study took place in four distinct regions primarily differing along geographic and ethnic lines. In the Highlands, the men were mostly Kikuyu; workers in the Kwale District were mainly Wadigo living near the coast; in Kisumu District they were predominantly Luo close to Lake Victoria; and the West Pokot workers were of the Pokot tribe in the arid North-West. More than 800 men in all participated (Latham, Stephenson, Hall, Wolgemuth *et al.* 1982).

A clinical examination was performed on each man by a medical doctor (MCL) who then did anthropometric measurements to determine height, weight, weight-for-height, and arm circumference. Blood was taken to determine hemoglobin and hematocrit levels, and a smear made for malaria *plasmodia*. Stools were collected to search for helminth *ova*. Only in Kwale District, urine was collected and examined for *Schistosoma haematobium* eggs. These measurements were compared by region; for example, the average percentage of the standard weight-for-height for West Pokot was 77.7 %, while the highest average in Kisumu

was still only 86.9 %. Mean hemoglobin ranged from 13.2 g/dl in the Kwale District to 15.4 g/dl in Kisumu. In the Kwale District, 41.2 % of the men were anemic (hemoglobin below 13g/dl) compared to only 5.1 % in Kisumu (Latham, Stephenson, Hall, Wolgemuth *et al.* 1982).

When variables were examined in conjunction with one another, more differences between the regions could be seen. For example, anemic men in the Kwale District who were infected with parasites were likely to have even lower hemoglobin levels than those who did not carry parasites. In West Pokot, the more *Plasmodium* present in the blood, or the more enlarged the spleen was, the lower the hemoglobin level was likely to be. In Kisumu, however, these trends were not visible. This Kenyan study helped to further establish the link between iron deficiency, climate, and geographic location (Latham, Stephenson, Hall, Wolgemuth *et al.* 1982).

Anemia in pregnancy in Liberia

It is well-known that anemia is a significant risk during pregnancy, especially in developing countries. A study was conducted in Liberia to better understand the prevalence and causes of nutritional anemia, and to determine whether iron treatment was effective.

Women who were between 22 and 26 weeks pregnant were invited to participate in the study and were followed until the 36th week. They were randomly assigned to one of four groups, each receiving a different treatment: group one received ferrous sulphate once a day, and group two, three times a day; group three was additionally given folic acid, and group four received antimalarials as well. A fifth group consisted of women who did not receive antenatal treatment while a sixth group was made up of average, non-pregnant women .

The women were first examined at 26 weeks of gestation, and additionally 4, 8, and 12 weeks later. At 28 weeks, there was no significant difference in hemoglobin and hematocrit levels between the groups, although each group had increased levels of each when compared to their 24-week levels. By week 32 of pregnancy, there was still no major difference between the groups, but the levels continued to increase. By week 36, the treatment groups were still not significantly different. However, their mean hemoglobin level was 11.2 g/dl compared with 9.5 g/dl for the non-treated group and 12.7 g/dl for the non-pregnant group.

This study showed that in all four groups, hemoglobin and hematocrit levels increased in women supplemented with iron from 24 to 36 weeks of pregnancy, and the levels at 36 weeks were significantly higher than in a group of similar women who did not attend pre-natal examinations. But it also shows that the groups receiving iron once a day, did as well as those receiving iron more than once a day, or those receiving folate and iron, or those receiving iron and antimalarials. Additionally, the proportion of women with anemia dropped from 78 % before the treatment to 45 % after (Jackson and Latham 1982).

Anemia in the Caribbean

In order to best manage iron deficiency and anemia, one must be aware of the population that is affected. During the 1960s and 1970s, various studies were conducted to

determine the prevalence of anemia in the Caribbean. A review was later published summarizing their results. Unfortunately, according to the review's authors, the studies were too few and mostly conducted in the larger islands, leaving little knowledge about the more sparsely populated and less touristy spots (Johnson, Latham and Roe 1982a).

In all of the studies reviewed (conducted in such locales as Jamaica, Barbados, Trinidad, Guyana, St. Lucia, Grenada, and Anguilla), a relatively high prevalence of anemia was observed in all groups, regardless of age or sex. However, in all regions the prevalence was particularly high in young children and in women of childbearing age. For example, in a study in Trinidad and Tobago, 80 % of all children under 5 years were anemic, as well as 33.8 % of children from 6 to 14 years and 32.2 % of women of childbearing age, but only 7 % of males over age 15 were anemic (Johnson, Latham and Roe 1982a).

In a 1971 National Food and Nutrition Survey of Guyana, mean corpuscular hemoglobin concentrations were suggestive of iron deficiency (lower than 31 %): 13-14 % in children under 14 years of age, 13 % in males over 14 years, but 34 % in pregnant women (Johnson, Latham and Roe 1982b).

A low intake of dietary iron is among the most important contributors to low hemoglobin in humans, and is judged to be the major cause in the Caribbean. In various surveys reviewed, between 42 % and 58 % of households were deficient. While low serum folate levels have been found to be somewhat prevalent in most of the Caribbean islands, a study conducted among pregnant women in Trinidad and Tobago found only 3 % had anemia caused purely by folate deficiency. And since animal foods are widely consumed in the Caribbean population, vitamin B₁₂ deficiency was removed from the list of possible causes. Helminths were also seen as relatively unimportant, since their prevalence across the Caribbean varied widely while anemia incidence did not (Johnson, Latham and Roe 1982a).

Anemia in Guyana

The prevalence of anemia is high in many parts of the world, but the causes are not always similar. For this reason, studying its etiology in different regions is important. Alan Johnson as part of his Cornell University Ph.D. dissertation conducted research in his native Guyana. He studied 590 persons of all ages to determine hemoglobin level, anemia prevalence, dietary nutrient intake, and anthropometric data (Johnson, Latham and Roe 1982b).

In this study, anemia was found to be more common in rural areas than urban; also, the higher the prevalence of protein-energy malnutrition (PEM) in an area, the higher the prevalence of anemia was in that same area. As found by numerous others, anemia was most frequent in pregnant and lactating women, while males over age 14 had the lowest prevalence. Accordingly, 36.8 % and 17.5 % of pregnant and lactating women, respectively, had moderately severe anemia (hemoglobin below 10 g/dl), while it was the case for only 1.3 % of males over age 14 (Johnson, Latham and Roe 1982b).

While iron-deficiency anemia is the most common form of anemia around the world, other types are certainly not rare. In this Guyana study, roughly a third of the 299 anemic subjects were thought to have pure iron-deficiency anemia, and the researchers concluded almost everyone else suffered from anemia due to a combination of deficiency in folic acid,

iron, and vitamin B₁₂. Only 2 % of the anemic population was estimated to be deficient in only folic acid or vitamin B₁₂ (Johnson, Latham and Roe 1982b).

Parasitic infection was also found to be correlated with anemia. Based on stool samples obtained from the study participants, the researchers determined that 19.3 % suffered from intestinal parasites. These were most common in children under age 14, with almost one in four infected, and least common in males over that age, with a prevalence of only 5.6 %. As children are one of the most likely groups to be anemic, and older males are the least likely, it is clear there is a correlation between the two (Johnson, Latham and Roe 1982b).

Iron supplementation and growth

Ferrous sulfate and physical growth

Until recently, little research had been conducted on the correlation between iron deficiency and growth. In 1986, a 32-week study was performed looking at iron supplementation in Kenyan schoolchildren. Twenty-nine children received 400 mg of ferrous sulfate daily while 26 children got a placebo tablet; the children were statistically similar in all aspects at baseline (Latham, Stephenson, Kinoti, Zaman *et al.* 1990).

The children receiving the iron gained significantly more weight, height, arm circumference, and skinfold thickness; those children in the iron group who had the lowest baseline hemoglobin levels also had the greatest increase in skinfold thickness, possibly indicating a better response to the iron than the other children. The researchers came up with three possible explanations for the increase in growth associated with the increase in iron intake: iron deficiency may result in nutrient malabsorption; lack of iron might reduce immunocompetence; and lastly, iron shortage may cause anorexia. All explanations required further study (Latham, Stephenson, Kinoti, Zaman *et al.* 1990).

Ferrous sulfate and appetite

Few studies had measured the relationship between appetite loss and iron deficiency until a study was conducted in a rural primary school in coastal Kenya. The latter was part of the research for the Cornell Ph.D. dissertation of Jeanne Lawless. The 86 children participating in the study were randomly divided into two groups. The first group received a daily ferrous sulfate tablet, while the second group received a daily placebo tablet. The children were offered an unlimited amount of *uji* (a maize based thin porridge, with a small amount of added milk and sugar). The amount eaten was recorded and each child was asked, using an appetite scale, subjectively to describe his, or her, appetite in the past week. Weight, height, arm circumference, and skinfold thickness were measured before and after the trial. Appetite tests were performed twice during the study (Lawless, Latham, Stephenson, Kinoti *et al.* 1994).

Both the placebo group and treatment group had a high prevalence of anemia at baseline. After 3 months, the hemoglobin levels in the placebo group fell significantly, while those in the treatment group rose by a significant amount, decreasing anemia prevalence in that group. By the end of the trial, children in the treatment group consumed notably greater amounts of *uji* and reported a greater appetite than those in the placebo group. As loss of

appetite is sometimes associated with anemia, it is plausible that the increased hemoglobin levels in the treatment group resulted from the greater food intake. In turn, it is very plausible that, as appetite improved, this resulted in a greater energy consumption during the trial, in turn resulting in greater weight and height increments in children in the treatment group compared with those in the placebo group (Lawless, Latham, Stephenson, Kinoti *et al.* 1994). More research is needed to confirm this very important finding that providing medicinal iron to poorly growing anemic children, will improve growth as well as raising hemoglobin levels,

Multiple micronutrient dietary supplementation

Double blind placebo controlled efficacy trials in Tanzanian school children

Virtually all researchers in the field acknowledge the prevalence of micronutrient deficiencies in the global South, and agree that the most prevalent and difficult to control is iron deficiency. It is also recognized that many persons, especially the poor in non-industrialized countries, have multiple micronutrient deficiencies. However the strategies for controlling the shortage of these nutrients have remained much the same in the past few decades: food fortification, dietary diversification, and medicinal supplementation have been the methods of choice. Recently, a fourth option has been explored - micronutrient dietary supplements given in physiologic amounts (Latham, Ash, Makola, Tatala *et al.* 2003). This was suggested, not to replace the other three options, but hopefully to add another approach.

To conduct efficacy trials, Michael received funding from the Micronutrient Initiative based in Canada and assistance from UNICEF. In addition, Procter and Gamble helped to develop a specially designed supplement, and most important, Cornell University had a partnership with the Tanzania Food and Nutrition Center (TFNC) (Dr. Godwin Ndossi, who did a Ph.D. degree with Michael, is Managing Director of TFNC).

The first double blind placebo controlled trial was conducted in six rural primary schools in the Dodoma Region of Tanzania. This research formed a part of the Ph.D. dissertation of Deborah Ash. One part of the study explored whether multiple micronutrient supplementation might have an impact on anthropometric measurements in children.

The supplement came in paper sachets containing the micronutrients, or similar sachets containing a placebo. One sachet contained 25g of powder which was added to 250 ml of water to make an orange-flavored beverage. The “fortified” one included ten micronutrients, including iron, to provide between 30 % and 100 % of the daily recommended intake. Under careful supervision, one sachet was consumed by each child every day a child attended school for 6 months. It was thought that the fortified beverage raised each child’s intake of each of those nutrients to above the daily recommended allowance (Latham, Ash, Makola, Tatala *et al.* 2003).

While any change in growth cannot be attributed solely to iron, it can be extrapolated from the higher hemoglobin levels in the fortified group that the iron did indeed have an effect. At baseline, both the fortified and non-fortified groups of children had approximately the same proportions of anemic children; after 6 months, there were significantly more anemic children in the non-fortified group. The children receiving the fortified beverage also

had a greater increase in weight, height, and BMI than those receiving the non-fortified drink, indicating that receiving iron along with the other nine micronutrients had a positive effect on growth (Ash, Tatala, Frongillo, Ndossi *et al.* 2003).

Micronutrient supplementation for pregnant women

Two years later a new research grant allowed the start of new efficacy trials in pregnant and lactating women in the same area of Tanzania. Dr. Diklar Makola, a South African MD used this research in part for his Cornell Ph.D. dissertation. Again a placebo controlled double blind efficacy trial was undertaken (Makola, Ash, Tatala, Latham *et al.* 2003).

Pregnant women in developing countries have two to four times the risk of developing anemia than their counterparts in industrialized countries. A study was undertaken to investigate whether a micronutrient-fortified beverage could reduce the incidence of anemia in pregnant women in the Mpwapwa and Kongwa Districts of Tanzania. The final data represented 259 women, who were monitored over 8 weeks. About half received the fortified beverage, while the others got a placebo beverage; each was prepared with 25g of powder. The women had two drinks each day which they prepared at home. Both added 368 kJ of energy per serving to the beverage, and the supplement also contained 18-144 % of the daily value of 11 micronutrients, including iron, folate, vitamin A, vitamin B₁₂, zinc, thiamin, riboflavin, and niacin (Makola, Ash, Tatala, Latham *et al.* 2003).

Before the trial began, the placebo and experimental groups were not statistically different. Every 2 weeks, each woman came into the study center to receive a new supply of the dietary supplement; during this visit, their weight, blood pressure, and other physical measurements were taken. A final exam was done at the end of the 8 week study (Makola, Ash, Tatala, Latham *et al.* 2003).

While anemia prevalence declined in both groups over the course of the study, women in the fortified group saw a much larger drop - the proportion of anemic women in the placebo group went from 59.1 % to 48.5 %, while in the fortified group the rate dropped from 63.8 % to 37 %. Hemoglobin rose almost twice as much in the fortified group as in the placebo group: an increase of 8.6 g/dl compared to 4.5 g/dl (Makola, Ash, Tatala, Latham *et al.* 2003).

These efficacy trials using a multiple micronutrient supplement are described in more detail in Chapter 8. The dietary supplement provided ten micronutrients plus iron. Intestinal helminthic infections and malaria, and research on their relationship to anemia are discussed in Chapter 3.

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Chapter 8 - Micronutrients

Introduction

This chapter entitled “Micronutrients” deals with mineral and vitamin deficiencies other than vitamin A, and iron and anemia. Vitamin A has been the subject of much research by Michael, his colleagues and graduate students; it is described in Chapter 6 in this monograph. Iron and anemia research and publications are reviewed in Chapter 7.

The current chapter is therefore a miscellany. It includes multiple vitamin B deficiencies leading to nutritional neuropathies; iodine deficiency disorders; fluoride and fluorosis; a particular study dealing with zinc; some references to niacin and pellagra, to thiamin deficiencies, and riboflavin deficiency; and finally some more recent research in Tanzania providing the results of efficacy trials of a multiple micronutrient dietary supplement, first in school children, and then in pregnant and lactating women.

Nutritional neuropathies (in Tanzania and Cuba)

Neurological diseases, with symptoms and signs often including ataxia, sometimes optic neuritis and painful feet, and which seem related to diet, are often grouped into a syndrome called “nutritional neuropathies”. It is extremely rare that the actual cause of the neuropathy can be determined with any degree of certainty.

In Tanzania, Michael described a neuropathy in prisoners, and because he could with some certainty evaluate their diet before and during the onset of the disease, he proved, with little doubt, its nutritional aetiology (Latham 1964a). The cases studied were all male prisoners who had been, for over 9 months, in the large Ukonga Prison in Dar es Salaam. All gave a history of “pins and needles” and severe burning pains in the feet. One patient described this as being like “sharp worms creeping about the soles”. Some also said they could not properly feel the ground with their bare feet. These symptoms, plus ataxia, became progressively worse, and some could not walk at all when admitted to hospital. Examination revealed marked ataxia, loss of coordination, but no evidence of optic atrophy or nerve deafness, signs often reported in cases of nutritional neuropathy.

Michael conducted a detailed investigation of the dietary intake of these prisoners before, and during, the onset of the disease. Their food rations were governed by law and had been unchanged for over 2 years: a maize based diet with smaller amounts of beans, groundnuts, meat, fruits, vegetables, red palm oil, whole milk powder and salt. It was difficult, then, to explain why this neuropathy had not occurred in previous years, and why it was now being seen in perhaps 2 % of the prison population, and not in the majority. The investigation revealed that:

- a few months prior to the outbreak of the disease, the prison had switched from 96 % extraction maize (very lightly milled, known as *dona*) to 60 % extraction maize (highly milled known as *sembe*);

- nearly all of the prisoners with the neuropathy never ate the groundnuts provided in their rations.

The change of diet to highly refined maize had greatly reduced the intake of B vitamins, but perhaps not to a level likely to cause deficiencies. However, not consuming groundnuts reduced B vitamin intakes to really deficient levels. The intake of thiamin was as follows:

	Thiamin (mean daily - mg)
(a) Diet with 96 % extraction maize	3.12
(b) Diet with 60 % extraction maize	1.56
(c) Diet with 60 % extraction maize when groundnuts not eaten	1.05
(d) Diet as in (c) allowing for 20 % loss in nutrients in wastage and cooking	0.84

There would have been similar reductions in riboflavin, niacin, and other B vitamins.

This neuropathy in Tanzania had clinical manifestations very similar to the “burning feet” syndrome, which was widely reported as a serious disease among European prisoners held by the Japanese in Southeast Asia during World War II. That condition did not respond well to doses of thiamin, riboflavin, and niacin, but a dramatic improvement was reported after receiving pantothenic acid (Walters 1966). In neither location were the symptoms, nor the clinical signs, those seen in classic beriberi.

As a result of the findings in prisoners in Dar es Salaam, all prisons in Tanzania were mandated to return to rations based on lightly milled maize. Recommendations were made for adding B vitamins to milled cereals.

Michael in his writings, including in his textbooks (Latham 1979; Latham 1997), has stressed the need to consider multiple vitamin B deficiencies as the cause of difficult to diagnose neurological conditions, especially neuropathies. He cautioned against confining thought to the clearly defined clinical manifestations of thiamin, niacin and riboflavin deficiencies as multiple B vitamin deficiencies, including pantothenic acid deficiency, may cause different syndromes.

Some 30 years after he described the nutritional neuropathy in Tanzania, Michael was invited by the Cuban government to participate in an international workshop to assist in determining the cause and actions needed in respect to a serious epidemic neuropathy sweeping Cuba. The workshop was co-sponsored by the Pan American Health Organization.

In the *Lancet*, Michael described the origins of the Cuban epidemic, reviewed the research findings, drew some conclusions, and suggested control actions (Latham 1994). Between 1992 and May 1994, 51,000 cases of epidemic neuropathy had been reported in Cuba. Although optic neuritis was common in early cases, by far the majority of cases from 1993 on showed mainly peripheral neuropathy, often with ataxia, similar to the cases described in Tanzania three decades earlier.

President Fidel Castro attended the workshop on all 4 days, sitting in the audience for all plenary sessions. Many of the experts attending had conducted research in other countries

where neuropathies had been reported, some due to viruses, others to toxins related to alcohol consumption, or to other causes. Michael presented his findings from Tanzania, relating the neuropathy there to the current Cuban neuropathies. President Fidel Castro asked him questions following the presentation.

Other experts made strong cases for the epidemic being due to a virus infection. Cuban virologist Gustavo Kouri reported finding enteroviruses in the cerebrospinal fluid of many patients with the neuropathy. Dr. Melnick and Dr. Inoue, who gave their names to this enterovirus, supported the viral etiology of the neuropathy. Other experts showed an association with tobacco use, or with consumption of cassava which can contain cyanides, and/or with alcohol consumption. Michael's *Lancet* piece (Latham 1994) stated:

There was broad agreement at the workshop that the main cause of the epidemic was dietary. The Cuban food rationing system favours children and pregnant women, a point that explained why the epidemic tended to spare children. The main nutrient deficiencies causing the neuropathy were probably those of the B complex vitamins and perhaps anti-oxidant vitamins such as carotene. Daily *per caput* thiamin intake in Cuba in 1992 was reported to be only 1.1 mg. Men generally received only 56 % of their requirements, a deficiency aggravated by the high carbohydrate content of the diet and their high level of physical activity. A deficiency of the other B vitamins may have contributed to the difference between the syndrome observed and classic neuritic beriberi. The epidemic rapidly subsided after the government began to distribute vitamin supplements. For ethical reasons there were no "control areas". Several of the few new cases of neuropathy have reported that they did not consume the vitamin supplements, or took them irregularly.

Cuba faces the problem of whether to continue to provide vitamin supplements for as long as the economic and food situation remains critical. Suggestions to improve agricultural production, to encourage production of native fruits, vegetables, legumes, and small animals, and to open up the informal economy were raised. A recommendation to consider fortifying either wheat flour or rice (both items in the rations), or to move to less refined wheat and rice, was acknowledged by Cuban participants, including Cuban leaders.

When Michael asked Fidel Castro why he, a busy President, had spent much of 4 days attending and participating in a technical workshop on the Cuban epidemic neuropathy he replied something like this:

We have had epidemics in Cuba before. For example we had a large outbreak of Dengue fever. I knew the cause. I knew that what we had to do was to control *Aedes aegypti* mosquitoes, which transmitted the disease. We did so, and ended the epidemic. But here, with this epidemic neuropathy, some experts are telling me it is due to a virus; others say it is due to contamination of rum with methyl alcohol; others relate it to greater consumption of cyanides in cassava due to food shortages; and some are even blaming tobacco use. So I worry, when we do not know the cause, whether I will get the disease, or will it sweep through our young visitors on the Isle of Youth. I cannot rest easily until I know the cause. We must know the cause in order to end the epidemic.

Niacin, riboflavin and thiamin deficiencies

Niacin deficiency leading to pellagra occurs sporadically in Tanzania, whereas riboflavin deficiency is prevalent. In the international statistical classification of diseases used in the country, pellagra is only reported if it occurs among in-patients. As the vast majority of those with the disease are not hospitalized, the total figures given for the country are misleading. However, they serve as a record of severe cases and they do indicate the geographically scattered occurrence of the disease, which occasionally erupts in a large localized outbreak.

In 1963, such an episode occurred near Kondoa Irangi, with 176 cases diagnosed in a period of 2 months. The previously held assumption that pellagra was a sub-tropical rather than a tropical disease, and that it was seen only in institutions or towns in the tropics, is false. The author has seen many cases among poor rural Tanzanians living off subsistence agriculture very near to the equator. The disease does not seem to occur among those whose staple diet is millet or sorghum. Possibly, the disease only reached Africa with the arrival of maize and cassava.

An interesting feature of the Kondoa outbreak was the frequent complaint by the patients that their skin lesions pained and burned when exposed to direct sunlight. Being dark skinned, none of them had ever suffered from sunburn. Yet, there is no doubt that the sensation they described was very similar to that experienced when a severe sunburn erythema is exposed to the direct rays of the sun (Latham and Stare 1967).

In a number of nutrition surveys in Tanzania, signs of riboflavin deficiency have been reported, including angular stomatitis and cheilosis of the lips, while scrotal (or genital) dermatitis was not often seen. Angular stomatitis and cheilosis of the lips have been especially prevalent in areas where crops had failed and famine measures were in operation. During the 1962 famine, among 173 people examined in Rufiji District, 12 % had angular stomatitis and 18 % cheilosis of the lips. Among 360 people in the Central Region in 1963, 14.4 % had angular stomatitis and 31.1 % cheilosis of the lips (Latham 1963) (Latham 1964b).

In 1966 Michael was somewhat “railroaded” by his Harvard University boss, the renowned Dr. Fred Stare, into producing the chapter *Present knowledge of thiamin* for the 1967 issue of the influential book *Present knowledge in nutrition* (Latham 1967). In this chapter he reviewed what was then known about thiamin, but he also discussed multiple B vitamin deficiencies such as was reported in Tanzania due to excessive milling of maize (Latham 1964a). Michael also used the opportunity to review the increasing prevalence, and clinical importance, of adult thiamin deficiency, particularly in alcoholics in the United States and in other industrialized countries. The conditions known as Wernicke’s disease and Korsakoff’s psychosis were described.

Wernicke’s disease is characterized by eye signs (nystagmus, diplopia, paralysis of the externi recti muscles, and sometimes ophthalmoplegia), ataxia, and mental changes. Korsakoff’s psychosis leads to a loss of memory of the immediate past, and often, to an elaborate confabulation which tends to conceal this amnesia. It is now generally agreed that any distinction between Wernicke’s disease and Korsakoff’s psychosis may be artificial in

the alcoholic patient. Korsakoff's psychosis may be regarded as the psychotic component of Wernicke's disease. Many patients with ocular signs, ataxia, and confusion of Wernicke's syndrome, recover to show typical signs and symptoms of Korsakoff's psychosis. This is better termed the Wernicke-Korsakoff syndrome and it often responds relatively well to thiamin doses alone, even when alcohol consumption continues.

In this chapter Michael suggests that rapid diagnosis and treatment are vital to prevent irreversible brain damage, and goes on to recommend some ingenuity in public health actions to reduce this major problem (Latham 1967). He wrote:

Possibilities include fortification of alcoholic beverages with thiamin, frequent "immunization" of alcoholics with thiamin and development of a suitable depot carrier to reduce the frequency of these injections, and the provision by public health authorities of thiamin impregnated snacks on bar counters. The cost of any of these measures would almost certainly be less than the present very high cost of caring for those who have suffered from Wernicke-Korsakoff's disease.

Alcoholic polyneuropathy, similar to neuritic beriberi, is also a disease largely due to a nutritional thiamin deficiency. Alcoholic amblyopia is similar to a condition seen in prisoner of war camps. In both, central scotomas are found and thiamin has been implicated as the deficiency.

The role of thiamin deficiency *vis-à-vis* deficiencies of pantothenic acid, riboflavin, vitamin B₆, and other vitamins in the "burning feet syndrome" has not been conclusively resolved (Walters, 1966). The spinal neuropathies reported from West Africa, and in prisoners of war in the Far East, may be due to deficiencies of B vitamins, but have not been proven to result from thiamin deficiency alone. In an outbreak of an ataxic neuropathy in an East African prison, Latham (1964a) showed that the diet of the afflicted prisoners contained less than 0.4 mg thiamin *per* 1,000 Calories, but was also relatively deficient in certain other vitamins. It would not be surprising to find several deficiencies involved in a single neurological syndrome. The nervous system is after all a finely adjusted mechanism, utilizing a wide range of complex enzyme systems to control energy supplied to it. The prosthetic group of these enzymes is frequently a vitamin.

It could be predicted that in the years ahead more will be learned of the interrelationship between the vitamins. It is possible that certain syndromes will be found to be due to a particular "mix" of vitamin intakes in persons on an inadequate diet, and that particular staple foods favor the type of "mix" which leads to one or other of these syndromes. This might explain the clinical differences in certain geographic locales or among certain groups of persons. It is hoped that the great advances being made in unraveling the chemical properties and enzyme functions of vitamins like thiamin will not only clarify their physiological action but, allied with dietary investigations and clinical study in man, will be able to define more clearly the precise etiology of the various deficiency diseases and syndromes (Latham 1967).

Iodine deficiency disorders

In 1960, the World Health Organization published Monograph No. 44, entitled *Endemic goitre*, giving a comprehensive summary of its world prevalence and geographic distribution (Clements 1960). In 471 pages quoting from 114 papers, many dealing with

Africa, no goitre studies in Tanzania were included. In 1963 Michael conducted the first goitre survey ever done in Tanzania; it was in the Ukinga highlands of Njombe District (Latham 1965a). The staple food for the majority of the population was wheat and the main green vegetable consumed was cabbage. During the survey, 3,002 persons were examined of whom 67 % were school children. This constituted 5.2 % of the total population of Ukinga (estimated from 1961 census at 58,000) and 18 % of children of school-age. The thyroid gland was examined, both visually and by palpation, and its size recorded using standard grading. Two thousand two hundred seventy-nine of those examined (75.9 %) were found to have goitre of which 13.3 % were adenomatous. This is the highest prevalence of goitre ever recorded in Africa (Latham 1966a). During the study a case of goitrous cretinism was found in a 4 year old boy, the first case of endemic cretinism ever reported in Tanzania.

Following the survey, research was conducted to assess the different factors playing a role in this endemic goitre (Latham 1965b). These studies included a comparison of the effects of adding iodine to the diet of one group of school children and withdrawing cabbage from the diet of a similar group. The only food frequently eaten by the Wakinga, which from work done elsewhere was known to have goitrogenic properties, was cabbage. Two facts pointed to the possibility of cabbage as a factor in the causation of goitre. First, cabbage was an important item in the diet of the Wakinga people where the goitre incidence was high, and it was not very extensively eaten elsewhere in Tanzania where its incidence was much lower. Second, the Wakinga believe that goitre became common only in recent times and it is known that cabbage became widely grown and eaten in Ukinga only between 1925 and 1935.

The two boarding schools in the Ukinga division were used to try and elucidate this question. Situated at Magoye and Tandala, these were the only residential institutions where the diet of a group of persons could easily be studied, altered or controlled. During the goitre survey, there was a very similar enrollment and goitre prevalence in these two schools. Unfortunately, there was not a third boarding school which could be used as a control. Each of the children at Magoye school were given 650 µg iodine administered as appropriately diluted Lugol's solution in water each week day. At Tandala school, cabbage was entirely withdrawn from the diet. It was replaced by sweet potatoes and carrots and each pupil was given a 50 mg tablet of ascorbic acid daily to ensure an adequate intake of this vitamin.

There was a striking reduction in the size and prevalence of goitre in the school where significant iodine was given and no significant reduction where cabbage was withdrawn.

It has been suggested that a generally poor diet may be a factor in the causation of goitre. Although goitre is frequently seen in communities where malnutrition is prevalent, no proven cause and effect relationship has been established for excess or deficiency of a definite energy giving foodstuff, nor for a vitamin deficiency. Despite this view, it seemed justified to try to find if there was any correlation between poor general nutrition and goitre incidence. A clinical examination was therefore carried out at certain schools in Ukinga. No correlation was found between the incidence of goitre and the number of signs of malnutrition observed. A comparison of signs of malnutrition and goitre incidence in various surveys carried out in Tanzania also shows no correlation between these factors.

Pollution or high calcium content of water were not believed to be factors of importance in the goitre endemic in Ukinga (Latham 1965b). A small trial was undertaken to

ascertain the effects of thyroid extract on the larger goitres. It was found to be effective in reducing goitre size and few side effects were encountered. However, its use is not recommended for mass therapy.

Legislation, either national or local, to ensure iodization of salt, was recommended to the government as the best solution to the goitre endemic. Because the salt used is mostly coarse and originates mainly from the hot humid coast of Tanzania, iodization of salt with potassium iodate (rather than iodide) to produce a level of one part of iodine to 20,000 parts of salt has been suggested.

In the years following this specific goitre survey, Michael reported on goitre prevalence in other areas of Tanzania. This showed ranges from 13.9 % in the Rufiji District near the Indian Ocean, 22.5 % in Arusha District in the north, 29.3 % in Songea District in the southwest, and 9.7 % in the Central Region (Latham and Stare 1967). Tanzania now has legislation for mandatory iodization of all salt sold.

Fluoride and fluorosis

It has long been known that fluoride, either naturally occurring or when artificially added to drinking water to provide a level of about one part of fluoride *per* million parts of water (1 ppm), will greatly help reduce dental caries (Latham, McGandy, McCann and Stare 1970). Much higher levels, above about 4 ppm over long periods, have for long been associated with a condition of the teeth termed dental fluorosis and with bone changes often termed skeletal fluorosis

When he was directing the Nutrition Unit of the Tanzanian Ministry of Health and teaching in the Medical School, Michael was made aware that streams in the Arusha district had high levels of fluoride, and that dental fluorosis was common. No survey had ever been conducted. In 1965 Michael conducted the first ever survey of dental fluorosis in Tanzania. He elicited the assistance of Dr. Paul Grech, a consultant radiologist with the Ministry of Health in Dar es Salaam, to collaborate in the study. Designed to determine a number of conditions that might be related to fluoride intakes, it was conducted in the Arusha District in northern Tanzania around the base of Mount Meru. Many streams originate on this 14,978 foot-high mountain and flow down through, or near, various habitations where the water is used for domestic purposes, including drinking and cooking. Children and adults were examined at four localities in the District. In all of them, the main source of water used ranged from 6 to 46 ppm of fluoride (Latham and Grech 1967).

The survey included examination of the teeth for discoloration, mottling and other features related to fluorosis, but also for dental caries. The neck was examined for goitre and the fingers on both hands for nail abnormalities. A group of volunteers, who were over 40 years of age and had lived in the area for over 10 years, were offered x-rays to determine skeletal changes (Grech and Latham 1964).

Of 1,243 persons examined, 1,180, or 94.9 %, had some degree of dental fluorosis. The mottling was graded, and over 80 % had severe mottling. Another feature of dental fluorosis is “wearing” of the teeth, and about 20 % of persons showed markedly worn teeth.

Dental caries rates were judged by counting the number of decayed, missing and filled teeth (the DMF index) in each person. Extremely low rates of dental caries were observed with a total of only 719 decayed, missing and filled teeth from the whole sample or a total DMF index of 0.58.

Goitre was found in 27.4 % of the 1,243 subjects examined. Most were small grade I goitres, but 67 had larger grade II, and 4 had very large grade III goitres.

Skeletal fluorosis is seldom studied, and had hardly ever been reported from Africa. In the survey, 87 % of the 112 persons examined radiologically showed bone changes believed due to excess fluoride intake. The main radiological findings were:

- (1) increased density of bone in forearms, spines and skulls, which was judged to be due to increased osteoblastic activity;
- (2) marginal lipping of the vertebral bodies in 45 % of subjects, mainly in the lumbar segments;
- (3) calcification of ligaments and muscular attachments;
- (4) trabeculation indicating ossification.

A clinical examination found that 75 % of those x-rayed complained of pain in their bones, the most common being in the back, chest and legs, in this order. Backache was found to be relative to the degree of spondylitis.

In the *Lancet*, Michael reported unexpectedly high rates of finger clubbing in those with both dental and skeletal fluorosis in Tanzania (Latham 1966b). Finger clubbing, a condition of interest to clinicians, is usually associated with pulmonary disease, including tuberculosis, bronchiectasis, carcinomas, congenital heart disease, and others. It had never before been related to fluorosis. These subjects had no evidence of pulmonary or cardiac causes of finger clubbing. Michael speculated that skeletal fluorosis might be causing osteosclerosis of the skeletal thoracic cage and calcification of some supporting tissues, resulting in such rigidity of the chest as to impair oxygenation, thus producing the circumstances required for the development of clubbing of the fingers.

In summary, this research showed that fluorine “poisoning” was endemic in the Meru area, and that bone changes, previously unrecorded in this part of Africa, were very common in this area.

Factors related to zinc intake in Bangladesh

As part of her Ph.D. dissertation in the field of Nutritional Sciences at Cornell University, Anne-Marie Mayer conducted a broad range of studies on factors related to zinc intake in Bangladesh. She pointed out that iron, zinc and iodine deficiencies were prevalent in Bangladesh where zinc and iodine were often deficient in the soil. Zinc was used as an example of a nutrient that is deficient both in soils and humans. Iron was included since it varies with different varieties of rice, the staple crop. The study aimed to explore connections between soil, crop and human micronutrient deficiencies and attempted to identify new approaches and avenues for agricultural nutrition interventions.

The research team collected several hundred samples of soil and rice from farmers in six districts in two seasons. A diet and nutrition survey was undertaken in 156 households in four villages in four districts from various parts of Bangladesh. It included a 24-hour dietary recall, collection of rice, and samples of children's hair. Nutritional assessments were carried out in children. Of 231 children examined, 18 (8 %) exhibited palpable thyroid enlargement. Of 244 with urine samples, 100 (41 %) had urinary iodine below 10 µg/L. Of 204 with blood samples, 113 (55 %) had hemoglobin levels below 11 g/dl. About half (47 %) of households were consuming homegrown rice. Otherwise rice was obtained from other local sources.

Inductively coupled plasma atomic emission spectrometry was used for mineral analyses. Fifty-one percent of the soil samples had < 0.8 ppm available zinc, a critical level for rice production. During both seasons, soil zinc was significantly and positively related to unpolished rice zinc after controlling for soil pH ($p < 0.001$ for irrigated and $p < 0.05$ for monsoon season). Rice grown in two seasons on high-zinc soil (> 0.8 ppm available zinc) were 6 % and 13 % higher in zinc than on soils < 0.8 ppm. Total dietary zinc would increase from 6.4 mg/d to 9.0 mg/d if children (5-11 years) consumed rice from the "high-zinc" village compared to the "low-zinc" village. The zinc content of local varieties differed by 31 % and 41 % in two seasons. Milling removed from 10 to 50 % of the unpolished rice zinc. The polished rice zinc ranged from 0.70 to 2.39 mg/100g (mean 1.29; SD 0.35). Cooking losses averaged 2 % or 16 % depending on the practice of discarding cooking water. With 68 % of the children's dietary zinc provided by rice, the total dietary zinc intake of children was highly influenced by the variability in the rice zinc. The children's hair zinc was positively related to the zinc content of the rice they consumed ($p < 0.01$). It follows that optimizing the zinc content of rice through changes in agriculture and processing would be useful for tackling human zinc deficiency. Children from households using pond water for cooking also had higher levels of intestinal infection than children from households using tubewell water. Using this information, the research demonstrated the connections between local soil conditions, diets, and nutritional status (Mayer, Latham, Duxbury, Hassan *et al.* 2002).

It was concluded that improvements to local systems, including choice of crop varieties, soil and crop management, food processing and household water sources, can enhance children's zinc status through optimizing the zinc content of rice and preventing intestinal infections (Mayer, Latham, Duxbury, Hassan *et al.* 2003).

Efficacy trials of a multiple micronutrient supplement

Micronutrient deficiencies, particularly of iron, iodine, and vitamin A, have been recognized for many years as serious health problems in developing countries, including in Tanzania. Well over two billion people worldwide are believed to suffer from these deficiencies, with women of reproductive age and young children at greatest risk. In addition, it is known that in many developing countries, zinc deficiencies are also prevalent; inadequate intakes of vitamin C may adversely influence iron absorption; vitamin E is an important antioxidant; and the following vitamin B-complex deficiencies have adverse results: riboflavin (widespread ariboflavinosis), vitamin B₁₂ (anemia), vitamin B₆ (neuropathies), folate (anemia and spina bifida), and niacin (pellagra). Very few developing countries have in place strategies to control these micronutrient deficiencies.

Despite the wide prevalence and devastating consequences of micronutrient deficiencies worldwide, the established approaches to control them have remained much the same for more than three decades and consist mainly of the following three strategies:

- *Dietary diversification.* Clearly the aim of nutritionists is to ensure that people consume a variety of foods that together provide adequate quantities of all the micronutrients necessary for health. Actions taken may include nutrition education programs to achieve behavioral change, as well as increasing and diversifying regional and/or household production and consumption of micronutrient-rich foods.
- *Food fortification.* The addition of a micronutrient to a food item that is widely consumed by a population at risk of a deficiency has been a widely used strategy for many years in industrialized countries.
- *Medicinal supplementation.* This includes the provision of a micronutrient often through the healthcare system, usually in the form of a pill, liquid, or injection. It may include (a) periodic administration of megadoses of a specific micronutrient, such as vitamin A or iodine, or (b) regular provision of medicinal amounts of a micronutrient in amounts much higher than the recommended daily intakes (RDI), for example, iron supplements during pregnancy.

These three strategies have had both successes and failures, and each has disadvantages and limitations. Many agree that food diversification offers the best long-term approach that is likely to be sustainable. But often it requires either major change in agricultural production, including home gardens, or in higher incomes for the poor, allied with nutrition education. Therefore, progress is slow in many non-industrialized countries, and in some African countries with a deteriorating economic situation, food diversification is unlikely to reduce substantially micronutrient deficiencies in the near future.

The conditions needed for successful fortification vary depending on the foods widely eaten in a country and the nutrients being considered for fortification. In some countries several commonly eaten foods do pass through commercial processing where fortification is feasible. Salt iodization has greatly reduced iodine deficiency disorders in many countries, including Tanzania. But in many non-industrialized countries it is difficult to find a suitable food vehicle to fortify with iron or vitamin A. To be suitable for fortification, a food must be consumed regularly by those at risk of the deficiency—often children and women in poor families. Especially in rural areas, those suffering from micronutrient deficiencies may purchase few manufactured or processed foods.

There are two kinds of medicinal supplements. First there are those taken in pharmacologic doses daily or at frequent intervals, and second are those prescribed to be consumed in megadoses at intervals of 4 to 24 months. Ferrous sulfate and folate are examples of the former, and vitamin A and Lipiodol® (iodinated poppy seed oil) and oral iodine are examples of the latter. Medicinal supplementation is dependent on a delivery system, which is often relatively costly if the supplement is to reach those at risk. Other problems include poor compliance, which is common with iron prescribed during pregnancy, and low participation rates, such as when massive dose vitamin A supplements are offered over time.

A World Bank review of micronutrient programs found three common problems arising from the implementation of any or all of these strategies: (1) lack of appropriate consumer demand; (2) lack of appropriate delivery infrastructure with adequate access for poor women and isolated populations; and (3) lack of honest, efficient, and technically competent enforcement systems for food fortification (World Bank 1994).

Micronutrient dietary supplements offer a fourth approach and one that can control several micronutrient deficiencies simultaneously. This approach differs from medicinal supplementation in that several micronutrients are provided at the same time; the micronutrients are provided in physiologic amounts, rather than in megadoses; the supplements can be self “prescribed” or purchased in the marketplace, rather than through the healthcare system; and they are usually pleasant to take, and therefore avoid problems of compliance often associated with medicinal supplements. However, micronutrient dietary supplements have not been very widely used to control common deficiencies in developing countries. The dietary supplement we used has some features of fortification and others related to more common forms of supplementation.

In Tanzania, micronutrient deficiencies, including iron deficiency anemia, vitamin A deficiency and iodine deficiency disorders are recognized as important health problems (Kavishe 1991). We conducted two separate double-blind, placebo-controlled field trials in the Mpwawa District of Dodoma Region in central Tanzania. The aim was to investigate the efficacy of a multiple micronutrient dietary supplement in young primary school children in the first trial and in pregnant women in the second one. Some of the pregnant women were followed postpartum during 4 weeks of lactation (Latham, Ash, Makola, Tatala *et al.* 2003).

The trials were collaborative including the Tanzania Food and Nutrition Centre (TFNC), Cornell University (Ithaca, NY, USA), United Nations Children’s Fund (UNICEF), the Micronutrient Initiative (MI) (Canada), and the Procter & Gamble Company (P&G) (Cincinnati, Ohio, USA). The dietary supplement was supplied to the research team in individual-serving paper sachets each containing 25 g of a fine white powder. The contents of a sachet, when added to 250 ml of water, turned orange and produced a pleasant tasting orange-flavored beverage. Each sachet contained 5.4 mg of iron (ferrochel), 1750 IU of vitamin A (retinyl palmitate), 45 µg of iodine, 5.25 mg of zinc, 72 mg of ascorbic acid, 0.6 mg of folic acid, 1.2 mg of riboflavin, 3 µg of vitamin B₁₂, 0.7 mg of vitamin B₆, and 10.5 mg of vitamin E. For the pregnancy study, 5.0 mg of niacin was also included in the sachet.

For each trial, P&G provided an equal quantity of nonfortified supplement (placebo) identical in appearance and taste to the fortified supplement. The sachets containing the fortified and nonfortified beverage supplements differed only in the color of the package. The study participants, as well as the research team, did not know which sachets were fortified and which were not until the results had been analyzed, when the code was broken. Different-colored sachets were used for each of the trials.

In these trials the supplement was orange flavored to make a very palatable drink when added to water. However the same powdered supplement, unflavored, would be suitable to use as an addition to the family cooking pot, to a maize based staple (in Tanzania

cooked as *ugali*, or a maize gruel (*uji*) for children. So it could be utilized in what has come to be termed a “sprinkle”.

The efficacy trial in children involved 774 young primary school children recruited from six rural primary schools in Mpwapwa District (Ash, Tatala, Frongillo, Ndossi *et al.* 2003). The main objective of the trial was to determine whether a dietary supplement providing 10 micronutrients in physiologic amounts resulted 6 months later in differences in measures of iron status, serum retinol, and child growth when compared with children receiving a nonfortified supplement identical in appearance and taste. Children were randomly assigned to be in either the fortified or nonfortified group. The children, teachers, and researchers did not know which sachets—the blue ones labeled “J” or the green ones labeled “K”—were fortified. During the morning break, children lined up according to the two groups and were served their beverage. Teachers recorded attendance in the compliance notebooks.

The children were examined at baseline and 6 months later at the follow-up examinations. All had participated and consumed, on each school day attended, one sachet of either the fortified or nonfortified beverage. Baseline characteristics of children in the fortified and nonfortified groups were similar in terms of mean age, gender distribution, anthropometric measures (weight, height, and body mass index [BMI]), hemoglobin and serum retinol levels, and presence of helminthic infections in their stool samples.

The beverage was very well liked and consumption rates were very high. The percentage of days of possible consumption during the trial did not differ between the two groups (79.9 % in the fortified and 81.1 % in the nonfortified group). At baseline, 18.5 % of the children in the fortified group and 19.1 % in the nonfortified group had hemoglobin levels below 110 g/L, while 21.4 % in the fortified group and 20.6 % in the nonfortified group had serum retinol levels below 200 µg/L. Height-for-age Z-scores were below -2 in 50.5 % of those in the fortified group and 49.5 % in the unfortified group. In none of these measurements are the differences significant between the two groups at baseline.

At the baseline examination, there were no significant differences in mean weight, height, or BMI between groups. However, at follow-up, incremental changes were significantly higher in the fortified compared with the nonfortified group, for weight (1.79 vs 1.24 kg, a difference of 0.55 kg); height (3.2 cm vs 2.6 cm, a difference of 0.6 cm); and BMI units (0.88 vs 0.53, a difference of 0.35).

Serum ferritin levels increased significantly in the fortified group, but there was no significant change in the nonfortified group. In those children with anemia at the baseline (Hb < 110 g/L) there was a significantly higher rise in hemoglobin concentration (9.2 g/L) in the fortified group compared with a nonsignificant rise in the nonfortified group (0.3 g/L). At baseline, there was no significant difference in the proportion of children with anemia (18.5 % vs 19.1 %) while at follow-up, there was a significant difference (chi-square = 0.005) in the percentage of children who were still anemic (26.3 % vs 35.6 %). The percentage of children in the fortified group whose serum retinol was below 200 µg/L declined from 21.4 % to 11.3 % between baseline and follow-up, a very significant improvement. In contrast, the decline in those with deficient serum retinol levels was not significant in the nonfortified group.

The pregnancy study in the Dodoma Region enrolled pregnant women attending six different clinics, five in Mpwapwa and one in Kongwa Districts. At baseline, 579 women were screened; 140 were excluded mainly because their pregnancies were too advanced (50 %) or because their hemoglobin levels were below 80 g/L (26 %). Of the 439 women who enrolled, the main results presented here relate to 259 women who both participated in the supplementation trial and who had not delivered 8 weeks after their initial examination. (Fifty-nine supplemented mothers delivered their infant before 8 weeks of follow-up had elapsed and another 121 women were lost to follow-up.)

The objective of the trial was to evaluate the effect of the micronutrient supplement on iron status, hemoglobin, and serum retinol levels. In a subgroup of women, breastmilk was obtained 4 weeks postpartum to determine retinol levels (Makola, Ash, Tatala, Latham *et al.* 2003).

At each clinic site, after the baseline examination, pregnant women were randomly assigned to receive either the micronutrient-fortified, or the nonfortified, dietary supplement. Each woman was carefully instructed on how to mix the contents of one sachet with about 250 ml of clean boiled water to produce a single serving of the orange-flavored beverage. They were requested to consume two sachets daily, one with the morning and the second with the evening meal. Each woman was provided with a plastic mug and a 2 week supply of supplement and was requested to collect new supplies every 2 weeks at the clinic for the duration of the 8 week intervention period. During each follow-up visit they brought back the empty sachets that were counted, thus serving as one method of measuring compliance.

Data collected at baseline included assessment of gestational age; information on parity and gravidity of the current pregnancy; history of medical problems and health status; phlebotomy to collect 5 ml of blood (2 ml of serum) for immediate determination of hemoglobin and later analyses of serum ferritin and C-reactive protein (CRP) levels; finger-prick capillary blood to prepare dried spots on filter paper for subsequent determination of retinol and thyroid stimulating hormone levels; and anthropometric data, including height, weight, mid-upper arm circumference, and triceps skinfold thickness. Most of the appropriate measurements were repeated at the 8 week follow-up examination.

At baseline, 61.4 % of the study participants were anemic (hemoglobin level below 110 g/L) with no significant difference between the experimental and the control groups. At the end of 8 weeks of supplementation, both groups experienced a decrease in the incidence of anemia: from 59.1 % to 48.5 % in the control group and from 63.8 % to 37 % in the fortified beverage group. This latter decline of almost 27 % resulted in a highly significant difference ($p = 0.019$) in the proportion of anemic women between the nonfortified and fortified groups at the end of the treatment period (48.5 % vs 37 %, respectively).

Both groups experienced a significant increase in hemoglobin concentration. However, mothers in the fortified beverage group had a mean increase of 9 g/L while those in the nonfortified group had a mean increase of only 4 g/L. Therefore, women in the fortified group experienced a 5 g/L greater increase in hemoglobin concentration when compared with women in the nonfortified group ($p = 0.015$).

There was no significant difference at the baseline in the mean ferritin concentration of the two groups (184.7 vs 189.1 µg/L). At the 8 week follow-up, however, the mean serum ferritin level was significantly higher (50.3 µg/L) in the fortified beverage group than in the nonfortified group ($p = 0.009$). Mothers in the fortified group had a significant mean increase of 30.4 µg/L, while mothers consuming the nonfortified beverage experienced a nonsignificant mean drop of 19.9 µg/L. Therefore, the fortified beverage appeared to result in a net improvement in ferritin concentration.

There was a decline in serum retinol levels between the baseline and follow-up examination prior to delivery in both groups of subjects. It is known that serum retinol levels decline during the last weeks of pregnancy and that it takes rather large doses of medicinal vitamin A to reverse this decline. However, in those mothers who had delivered their infants, the mothers consuming the fortified supplement had a significant improvement in serum retinol levels, whereas there was a marginally significant decline in mothers receiving the nonfortified supplement. At follow-up, mothers who had delivered and were in the fortified group had mean serum retinol levels 0.12 µmol/L higher than similar mothers consuming the nonfortified supplement. In a separate analysis, serum retinol levels were positively correlated with increases in hemoglobin, illustrating the importance of an adequate vitamin A status in the control of anemia.

Samples of breastmilk were obtained approximately 4 weeks postpartum in 50 mothers in the fortified group and 34 in the nonfortified group. Breastmilk retinol levels were significantly higher in mothers in the fortified group compared with mothers consuming the nonfortified beverage (mean of 1.24 µmol/L vs 1.06 µmol/L). In separate analyses, serum and breastmilk retinol levels were significantly positively correlated though breastmilk retinol levels were not associated with other measures of nutritional status, such as hemoglobin or serum ferritin levels. Consuming the fortified supplement was therefore significantly associated with higher breastmilk retinol levels.

These trials were initially designed to test the efficacy of a newly developed multiple-micronutrient supplement both in school children and in pregnant women. The results summarized above illustrate that consuming the fortified supplement, when compared with the nonfortified supplement, had a positive impact on measures of iron (in terms of hemoglobin and serum ferritin levels) and vitamin A status (in serum retinol levels) in both children and women; it appeared to improve the growth of children; and it also seemed to increase levels of retinol in breastmilk from mothers consuming the fortified beverage.

With UNICEF support, a Yale social anthropologist (Dr. Martin Benjamin) with extensive Tanzanian experience and fluency in Kiswahili was employed to examine social attitudes towards use of the dietary supplement. He concluded, without qualification, that women (1) like the beverage as a delivery vehicle; (2) prefer this dietary supplement to pills such as ferrous sulphate; (3) consider it beneficial to health; and (4) are willing, and able, to utilize the supplement properly and follow instructions concerning its use.

The multiple micronutrient supplement tested in Tanzania has been successfully used in almost identical form in efficacy trials in the Philippines (Solon, Sarol, Bernardo, Solon *et al.* 2003) and in Bangladesh (using adolescent girls) both with good results.

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Chapter 9 - Lactose and milk intolerance

Introduction

In the span of a few years starting in 1973, Lani Stephenson, Michael Latham, and their Cornell University colleagues contributed tremendously and importantly to the literature on lactose intolerance, and influenced policy. Their interest in the subject arose after loud and urgent public concerns were voiced, particularly in the United States, about providing milk as part of school lunches for non-Caucasian children. Newspaper and media reports indicating a high prevalence of lactose intolerance in non-whites was causing serious alarm. The condition was being transformed into a disease termed “lactase deficiency” requiring government action and broad medical attention.

The Cornell group proceeded to review the literature and do research on the implications of lactose intolerance in adults and children; to conduct research to produce a usable scaling of symptoms caused by excess lactose loads; to study the efficiency of simpler lactose tolerance tests using the Ames Reflectance Meter; to investigate milk drinking and lactose tolerance in the Maasai in Tanzania; and to study in Ethiopia whether milk was contraindicated in the treatment of children with kwashiorkor.

A generally accepted definition of lactose intolerance had emerged from early studies: “a low blood glucose rise and symptoms following a lactose load”. The Cornell group defined lactose intolerance as “a rise in blood glucose of less than 25 mg/100ml above fasting level”. This became widely accepted. Furthermore, the research began to show that lactose tolerance and intolerance based on the test does not lead to a dichotomy of symptoms but rather to a spectrum. Research was then conducted to demonstrate this. For the first time, a rating system of symptoms and their severity was developed.

Significance of lactose tolerance and its implications for milk consumption

Several authors have expressed concern regarding the use of milk in nutrition programs in countries where a high prevalence of lactose intolerance has been reported. The acceptability of milk in school feeding programs for black children in the United States has also been questioned.

The question to be considered is whether or not a glass of milk (11 to 12 g lactose) will overload the enzyme capacity of an individual with low lactase activity, if the milk is consumed during a meal. In other words, what are the practical limitations of being intolerant to lactose? Most studies that have investigated lactose intolerance have not considered the presence or absence of symptoms following the ingestion of milk, but have only looked at the effect of a test of lactose.

Lani and Michael, in a detailed study, have shown that subjects who are lactose intolerant can usually consume useful quantities of milk without undue symptoms occurring. They fed varying quantities of lactose in water, and lactose in milk, to 19 lactose tolerant and

16 lactose intolerant adults, on 10 different occasions. The amounts of lactose and of milk that could be consumed without severe symptoms were determined in each subject. All intolerant subjects could consume 1.25 cups of milk and 80 % could consume 2.5 cups without undue symptoms (Stephenson and Latham 1974).

In this study, a 12-point lactose score was devised and used to rate the severity of symptoms occurring in each subject following consumption of different quantities of lactose or milk. This provides a useful assessment tool. The study also showed an excellent correlation ($r = 0.94$) between blood glucose results using the simple portable Ames Reflectance Meter and the autoanalyzer (Stephenson and Latham 1975).

Having concluded from a small study including only adults from mixed backgrounds that lactose intolerant adults could consume useful amounts of milk without undue symptoms, a new study was planned in a school in upstate New York. This seemed important because Paige, Bayless, Ferry and Graham (1971) had reported that black school children in Baltimore drank significantly less milk offered to them at school lunch than did white children. They concluded that lactose intolerance was the reason. This had led to general concern, expressed both in the scientific literature and in the media, about the wisdom of including milk in school lunches. In a paper prepared for the United Nations we provided evidence that probably the majority of the world's non-white adults were lactose intolerant.

Two schools in Ithaca, New York, were selected for the study (Stephenson, Latham and Jones 1977). It included 222 children in Grades 1 through 6 divided almost equally by race and gender. There was no statistical difference in the quantity of milk consumed at the school lunch by black and white children, nor by gender. Younger children consumed significantly less milk than older ones. When asked about quantities of milk consumed at home, no significant difference was found between black and white children. It was a gratifying finding that black children were consuming similar amounts of milk as white children, both at school and at home; and were not reporting symptoms.

Lactose intolerance in young children

Following these important studies there remained a lack of data concerning the age at which children become lactose intolerant. The general belief is that all mammals, including humans, produce adequate amounts of lactase to allow them to utilize properly the lactose present in the milk of their mothers. A small study was conducted to examine lactose intolerance in families including young children. Lactose tolerance tests were performed on 34 healthy subjects from nine families of African, Asian, and Latin American origin, all currently living in the United States (Jones and Latham 1974).

The results showed that all the children under 5 years of age were lactose tolerant, thus dispelling the results of previous studies that showed non-Caucasian children between 3 and 4 years to develop lactose intolerance. All of the children were generally consuming at least 1.5 cups of milk per day. This suggests that continuing milk consumption delays the onset of lactose intolerance. Most of the children's parents were lactose intolerant.

Symptom response to lactose-reduced milk

Interest began to develop in the possible development and use of lactose reduced milk for those limited numbers of lactose intolerant people getting troublesome symptoms from milk consumption. This research was conducted in collaboration with Dr. Frank Kosikowski of Cornell's Food Science Department. He produced both whole and skim milk with 50 %, 60 %, and 75 % reduction in lactose content. For example, regular whole milk contains 25 g lactose per 500 ml, while 60 % lactose reduced whole milk contains 10 g lactose.

Using lactose intolerant adult subjects, a study was undertaken to (1) investigate the symptomatic response to milk in which the lactose content had been reduced by an enzymatic process and (2) compare symptoms reported following consumption of whole milks, skim milks, and aqueous lactose solutions (Jones, Latham, Kosikowski and Woodward 1976).

In the first part of the study, 16 lactose intolerant subjects (blood glucose rise < 25 mg/100ml) received 2.5 cups of low-lactose skim milk containing either 15 g lactose or 7.5 g lactose, 2.5 cups of regular skim milk containing 30 g lactose, and each of the three milks plus a small breakfast. The low lactose milks produced significantly fewer symptoms. The food given with the milk had no significant effect on symptomatic response. The second group of 17 subjects received 25 g lactose in water (250 ml), skim milk (500 ml) and whole milk (500 ml); 10 g lactose in lactose-reduced skim (500 ml) and whole milk (500 ml); and a placebo (250 ml). There was a significant positive relationship between amount of lactose consumed and symptom response. The form in which the lactose was administered (e.g., whole *vs* skim milk) was not significantly related to symptoms. It is concluded that in symptomatic subjects, a significantly greater quantity of low-lactose milk than regular milks can be consumed.

Theories on milk use and lactose intolerance including in pastoral people

In a review, Michael and Lani attempted to correct several misconceptions of lactose intolerance and its relation to milk intolerance in different cultural settings (Latham and Stephenson 1974). First they challenged the assumption that "many soured and fermented milk products are either lactose free or very low in their lactose content". Second, they contested the direct relationship between the lactase activity of a group and the geographic distribution of milk consumption. More precisely, many have contended that "the majority of members of pastoral milk drinking tribes in Africa have high lactase activity levels, as do most Europeans". Michael and Lani clearly showed that this conclusion was erroneously drawn from a very small sample. Furthermore, the assumption that the cultural tradition of cattle raising or dairying was related directly to lactose intolerance was also contested. And finally, when coupling the two findings that (i) persons with low levels of lactase activity can consume nutritionally beneficial amounts of milk without suffering severe symptoms and (ii) that tolerance – not a rise in enzyme activity but rather a gastrointestinal tolerance for undigested lactose – can build in intolerant individuals exposed to a large amount of milk, they suggested further that determinants of milk consumption far exceed just physiological intolerance. The latter may also be culturally and ecologically driven.

This was followed by a study in Tanzania (Jackson and Latham 1979). Lactose intolerance tests were performed on 148 Africans aged 5-14 years of age in the Kilosa District. These included 127 Bantus and 21 Maasai children. The Bantus do not traditionally drink much milk whereas milk is an important, even staple food of the Maasai. The results showed that 92 % of Bantus and 62 % of Maasai had blood glucose rises of less than 20 g/100 ml following a lactose load while fasting. Milk intake among these groups was studied. It was not mainly a function of intolerance, but mainly based on cultural preferences and milk availability, which in turn may be related to milk prices. It was concluded that intolerant populations can drink nutritionally useful amounts of milk.

Is milk contraindicated in the treatment of children with kwashiorkor?

For many years milk, often dried skim milk, has been a standard part of the dietary treatment for severe malnutrition, both kwashiorkor and nutritional marasmus. With work on lactose intolerance, and the discovery of low lactase levels in children with kwashiorkor, doubts were being raised about this. Diarrhea is a feature of kwashiorkor. Could this diarrhea be worsened because of the lactose in milk and the low intestinal lactase levels in these children?

The question was studied in Ethiopia, in a collaborative research between Cornell University and the Department of Pediatrics of the Ethio-Swedish Pediatric Clinic in Addis Ababa (Rothman, Habte and Latham 1980). Children admitted with kwashiorkor were followed to determine (1) whether a lactose containing diet causes an increased stool weight compared with those on a lactose free diet; (2) whether they had higher concentrations of sugar in their stools; (3) whether stool pH was lower; and (4) whether stool transit times were faster. Stool weights, total sugar, and transit times did not differ significantly. Those receiving a lactose containing diet had a small but significantly lower stool pH than those on the lactose free diet. Clinical recovery did not seem to differ.

It was concluded that milk is not contraindicated in the treatment of kwashiorkor in Ethiopia. Also, no reason was apparent why milk in moderate amounts should not be used as part of the diet for rehabilitating malnourished children. Bowie, Brinkman and Hansen state that even when diarrhea is induced by lactose malabsorption in malnourished children, this does not affect protein repletion (Bowie, Brinkman and Hansen 1963). They conclude, as have several international groups, that "milk and milk products should continue to be used in programs to eliminate malnutrition". The present study supports this view.

Conclusion

New research in the area of lactose intolerance in the last decade and a half both confirm, refute, and extend the research of Michael and his colleagues in the 1970s. One major series of recent findings confirm and extend the bidirectional relationship between lactose intolerance and milk consumption. First, one finding showed a "strong positive correlation between the dose of lactose consumed and the symptomatic response" (Suarez, Shannon, Hertzler and Savaiano 2003). Another showed that even those clinically considered to be lactose intolerant can, and should, drink a nutritionally relevant amount of

milk, especially to fulfill the body's daily calcium needs. Furthermore, the daily consumption of milk was found to mitigate intolerance by enhancing "colon bacterial adaptation" and reducing "the likelihood for symptoms of intolerance" (Suarez, Shannon, Hertzler and Savaiano 2003). These key findings both confirm the bidirectional relationship between intolerance and milk consumption and also extend the relationship by offering a biological mechanism, namely bacterial adaptation to lactose, as a mitigating mechanism to lessen intolerance.

Another series of recent findings confirm Michael and Lani's review that children of Africa, Asia, and Latin America commonly have low lactase activity and a flat lactose tolerance curve. The recent findings show that "lactase level can be ascertained with a modest degree of accuracy simply from the determination of the subject's heritage, because prevalence varies among ethnic and racial groups" (Suarez, Shannon, Hertzler and Savaiano 2003). And indeed Africans and Asians were found to be part of the group. Furthermore, the geographical and racial distribution is now attributed to an evolutionary hypothesis that three separate gene mutations occurred several thousand years ago where dairy products had been incorporated into diets. The survival advantage bestowed upon those with lactose tolerance as a result of the gene mutations led to "lactase persistence."

Two minor refutations of Latham et al.'s research are as follows. First, individual foods eaten in conjunction with milk can affect symptoms. It may be that, slowing the entry of lactose into the colon by eating something with milk improves fermentation and thus reduces symptoms. Furthermore, addition of chocolate to milk also mitigates the symptoms felt although the reason is unknown.

Second, the medium in which lactose is dissolved affects the symptoms felt. Namely, yogurt lessens the symptoms felt by intolerant individuals. This mitigation can be attributed to the bacteria found in yogurt, which reduces lactose levels by 4 % to 6 %.

Finally, new genomic research, namely the completion of the human genome project in 2005, has ushered in a richer understanding of the hereditary nature of lactose intolerance thereby extending the work of Latham and colleagues into a new field. Recent findings show that "regulation of intestinal lactase activity is under genetic control" (Suarez, Shannon, Hertzler and Savaiano 2003). And the gene regulating the synthesis of lactase has been mapped to chromosome 2 in humans.

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Chapter 10 - Nutrition and productivity

The relationship of nutrition to labor productivity clearly is of interest to those concerned with slow development in the non-industrialized countries of the South. But it seems to have been inadequately studied while results of research have not been much used to influence actions to address the problem. Strangely, funding for such research has not been easy to obtain.

Over the years, although not a central focus of their research, Michael and graduate students working with him (including for example Peter Heywood, June Wolgemuth, Lani Stephenson and Terry Elliot), have conducted a variety of related studies and Michael has written quite extensively about the issue.

Peter Heywood, with Michael and with David Call, conducted a study in Bogotá in Colombia for his Master's degree in 1971 (Heywood 1972) and research in Jamaica for his Ph D (Heywood 1974). In these studies, he examined the relationship between nutrition and physical activity/ productivity. The later work, partly conducted with funds provided to Michael by the World Bank, investigated nutrition and health factors in Kenyan roadworkers during strenuous work building rural access roads.

Bogotá study on nutrition and physical activity

In Bogotá, as part of the Bogotá-Cornell-Harvard study on the impact of malnutrition on mental development, activity levels of well nourished and malnourished children were compared (Heywood 1972). It was hypothesized that malnourished children scored more poorly on mental tests in part because they were less active, explored little and lost learning opportunities. This was an alternative to the prevailing hypothesis that their impaired mental development was due to organic brain damage caused by malnutrition, for which practically no evidence existed (Latham and Cobos 1971; Latham 1974). Habitual physical activity (with heart rate as an index) was measured as a general indicator of child-environment interaction opportunities. Seven malnourished children between the ages of 25 and 52 months were paired with age- and gender-matched well nourished children, to determine whether habitual physical activity, as measured during the child's normal activity for a 4-hour period at their homes, was less in the former. Children were defined as malnourished if they were 85 % or less for weight-for-height (W/H), and well nourished if above 95 % W/H, compared to anthropometric standards established for healthy children living in Bogotá. Heart rate was measured using the SAMI heart-rate integrator (Heywood and Latham 1971). A physical activity index was calculated by subtracting resting heart rate from mean heart rate during the child's normal 4-hour activity period. Malnourished children were found to be less active than the well nourished controls, findings which supported the hypothesis that malnourished children are limited in their child-environment interactions and hence in their learning opportunities necessary for "normal" mental development.

Jamaican study on nutrition and productivity

In Jamaica, where productivity among sugarcane cutters was known to be low, the investigation was on how nutrition impacted on productivity (Heywood 1973; Heywood 1974; Latham 1976). This was a cooperative study between the Caribbean Food and Nutrition Institute and Cornell. Nutritional status was determined by weight-for-height (W/H). Productivity was measured as the amount of cane cut each week. The hypotheses tested were that (a) productivity is dependent upon W/H of individuals; (b) an increase in energy intake will result in an increase in productivity; and (c) the effect of any increase in energy intake on productivity is dependent upon the baseline W/H of the individual. The study was conducted at two sugar estates in Jamaica during the 7 month crop period of 1972-1973. A total of 196 subjects, ranging in age from 20 – 65 years, were included. Half way through the season, subjects at one of the two locations were provided with a high calorie drink (formulated from molasses, sugar and orange juice) supplying 400 kcals/day; efforts to supplement at the other site failed. At the site that was not supplemented, productivity measured at baseline was 85 % that of the other site.

A W/H effect on productivity was also evident at the site where productivity was higher at baseline: after controlling for factors such as age, weight, height, and skinfold thickness, as well as many social variables including distance from work, off-season income, and number of dependents (note that workers' pay was based on the amount of sugar cane each one cut per week), significant differences were observed in amount of cane cut between those less than 85 % W/H as compared with those > 95 % W/H. Weight-for-height, a reasonable index of energy stores, could affect worker productivity for reasons such as (a) lower energy stores in the lower W/H group may prevent a constant level of production in the face of fluctuations, or occasional deficiencies, in energy intake, or (b) the lower weights observed among the lowest W/H group indicate lower VO₂ max, an important determinant of work output (Latham 1976). However, because this W/H effect wasn't demonstrated at the site where productivity was less at baseline, it was concluded that a significant level of productivity may be necessary before it is observed.

At the site where supplementation was provided, productivity after supplementation was greater than before. However, no increase in total 24-hour energy intake during the period of supplementation was observed. The productivity effect was due to either (a) an increase in work availability during the second half of the crop period when this measurement was taken, (b) to the timing of food intake, as the supplement taken during work breaks could have had some positive effect even if it resulted in reduced consumption of food during nonworking hours; or (c) to some other unexplained factors. It is possible that a "gang" effect occurred, in that cutters worked in groups and significant differences in productivity among these groups existed. Yet, the gangs did not differ in any of the variables tested relating to income, health, nutritional status, age and others. Social interaction among workers, including morale and other human factors, could also have contributed.

In this study, loss of weight over the season was generally insignificant and anemia was not a common problem. It was concluded that as productivity rises, it becomes dependent upon nutritional status as measured by W/H. Productivity rising is something that could only occur when the labor force size decreases and/or the amount of work available increases (Heywood 1974). It was concluded that nutritional status is an important factor influencing worker productivity among Jamaican cane cutters, and that supplementation of

the sort provided in this study would be likely to have a definite effect in a situation where unlimited work is available at all times to workers (Latham 1976).

Nutrition and productivity in Kenya

Much of the work on nutrition and productivity in Kenya investigated nutrition and health factors in Kenyan roadworkers doing strenuous work during the Rural access roads program (RARP) which began in 1974. The objectives of the RARP were to (i) expand the rural road network and improve access to the resources of the countryside, particularly to areas not previously served by a road; and (ii) to use workers as effectively as possible while favoring the use of human labor rather than mechanized or motorized techniques (Latham 1983). Latham and co-workers' early work in Kenya looked for (a) relationships between productivity and a large number of nutritional and health problems; (b) whether dietary supplementation at work is feasible and can show an increase in worker productivity and (c) whether the acceptability, feasibility and effectiveness of certain other interventions to improve health conditions possibly relates to worker productivity (Latham 1983). Later, the research group looked more closely at the degree to which interventions to reduce worm burdens in school boys has an impact on physical fitness, as measured using the Harvard step test.

A study was conducted in Nyeri and Kwale Districts on 269 male Kenyan roadworkers examining their work output in relation to nutrition and health (Brooks, Latham and Crompton 1979). Work productivity was measured as time taken by men to complete an assigned task, such as earth excavation, ditch digging, and wheelbarrow work. As an incentive, once the work was completed each man could leave work. Pay was for the task and not for hours of work performed. The two conditions most strongly related to productivity were workers' nutritional status as measured by weight-for-height (W/H) and hemoglobin level. Regression analyses of W/H on the time needed to complete a task showed a highly significant relationship, men with low W/H taking a longer period of time to complete a task than men with higher W/H. Anemia was rare among one group of workers living in the highlands but was prevalent in those residing in Kwale District where 34 % had hemoglobin below 13 g/dl which was significantly associated with low productivity. These results were the subject of an editorial in the *East African Medical Journal* in 1979 entitled *Nutrition and worker productivity* where more government and employer attention to the nutrition and health of employed labor was recommended.

A series of intervention studies ensued to determine whether it is possible to improve conditions that appeared to be adversely affecting productivity. A dietary supplementation study was conducted on male and female RARP workers from Murang'a and Kirinyaga Districts of the Central province of Kenya (Wolgemuth, Latham, Hall, Chesher *et al.* 1982). Two comparable groups of workers were offered either a "high energy" dietary supplement (1000 kcals/d) or a "low energy" one (200 kcals/d) at work. A thin maize porridge, locally called *uji*, prepared either with whole milk powder or skim milk powder, was used. There was a statistically significant increase of 13 % in productivity among those receiving the "high energy" supplement, as compared with a non-statistically significant 3 % rise among those receiving the "low energy" supplement. Increases in arm circumference and

hemoglobin levels were also shown to be significantly associated with productivity gains. The authors concluded that successful supplementation which improved nutritional status significantly increased productivity in these workers.

Because it was expected that improving both W/H and hemoglobin status of the workers would improve productivity, further studies were conducted to examine the feasibility of improving their nutritional status and anemia, though without measuring directly worker productivity. In one study, 150 male road workers in Kwale District were recruited between January and August of 1979 (Latham, Stephenson, Hall, Wolgemuth *et al.* 1983). At baseline examinations, 59 % had hookworm infections, 38 % were infected with schistosomiasis, 23 % were positive for malaria, 47 % had anemia, and 31 % had W/H less than 80 % of a reference value for healthy men. Three different interventions were conducted to reduce hookworm, schistosomiasis, or malaria. Significant improvements were observed in hemoglobin levels of anemic men treated for hookworm and in those receiving malarial prophylaxis, compared with those receiving a placebo. Successful treatment of urinary schistosomiasis was associated with weight gains. The authors concluded that intervention feasibility was good among the roadworkers, and that the associated costs were moderately low. They recommended that the treatment and control of these three infections receive high priority, not only because of their effects on the health of individuals, but also for the wellbeing of the communities where the conditions are endemic.

Other intervention studies conducted by Michael and co-workers among Kenyan roadworkers showed promise in a variety of other means for improving the health and wellbeing of individuals and communities, beyond the treatment for parasitic infections. Among the successful ones were provision of medicinal iron, as well as re-implementation of mid-day worker feedings (Latham 1983). Both of these have shown promise with regard to improved hemoglobin levels. While worker feedings deserve serious consideration, Michael is careful to point out the *pros* and *cons* and is adamant that this not be done in lieu of improved incomes. Perhaps of greater concern is the role agriculture plays in development in third world countries, where it is largely dependent upon human labor and worker productivity. Michael points out that because of developing countries' dependence on improved productivity for their future economic development, these health interventions have even broader implications due to the improved productivity almost certain to follow.

Physical fitness and worker productivity

Governments are more interested in measures of work performance than of physical fitness, and planners seek advice on which interventions are likely to increase work outputs. Much more is known about physical fitness than about labor productivity, in part because studies on the latter are difficult to conduct, time consuming, and expensive. Studies examining the relationship between nutritional status and physical fitness have shown that anemia caused by iron deficiency reduces work capacity and physical fitness, and there are clear physiological explanations for this. Anemia due to parasitic infections can be controlled which could reduce the anemia and improve physical fitness and consequently, productivity (Latham 1993).

Following their work in Kenya examining the relationship between health and productivity, Michael and co-workers were concerned with the potential impact of parasitic

infections on worker productivity through impaired physical fitness. Accumulating evidence in support of the control of soil-transmitted helminthes in order to improve productivity had not been able to determine to what degree functional capacity could be improved. Their research set out to measure improvements in physical fitness in order to determine what impact community chemotherapy programs might have. One study, conducted in 1986 along the Kenyan coast, looked at the effect of a single dose of the anthelmintic albendazole on physical fitness in primary school boys as measured using the Harvard step test (HST) (Stephenson, Latham, Kinoti, Kurz *et al.* 1990). Thirty-six boys with infection rates of hookworm (91 %), *Trichuris* (94 %), and *Ascaris* (40 %) were treated, with either a single 400 mg dose of albendazole or a placebo, after undergoing baseline physical examination and HST measures of physical fitness. They were reexamined 7 weeks later when all were treated. At baseline, physical fitness was generally poor, with only 21 % of the boys achieving HST scores judged to indicate good to excellent fitness (over 80). Those treated for infections showed improved physical fitness, despite continual exposure to reinfection and some incomplete cures. Since mean hemoglobin levels did not improve after treatment, the precise mechanism for the increased physical fitness was elusive. A decrease in resting heart rate was the most important linear predictor of the increase in HST scores, leading the authors to hypothesize that children felt better after treatment, were more physically active, and hence developed lower heart rates.

In order to test this hypothesis, another study was conducted in Kenya's Kwale District in 1989-1990 (Stephenson, Latham, Adams, Kinoti *et al.* 1993). School children were administered a single 600 mg dose of albendazole and followed for 4 months. Measures were taken at baseline and follow-up. Appetite, growth, and physical fitness of treated children improved as compared with those receiving a placebo. Physical fitness included improved HST scores, lower resting heart rate, and improved heart rates at 1, 2, 3 and 4 minutes post exercise. Improved weight gains were observed among the treatment group. Because hemoglobin changes were marginal after treatment, the authors speculated that improved appetite and growth of the school children was more due to a decreased production of cytokines normally produced by the body in response to parasitic infections, and that improved physical fitness was due to the increased appetite, growth and general well-being of the children.

More recent work on nutrition, physical activity and productivity

In a recent review of research examining the relationship between iron deficiency and reduced work capacity, a continuing consensus was reported among human and animal studies of a causal relationship between the two (Haas and Brownlie 2001). The studies measured work capacity as aerobic capacity, endurance, energetic efficiency, voluntary activity and/or work productivity. The authors conclude that reduced work productivity observed in field studies among iron deficient subjects is likely due to the anemia and reduced oxygen transport, and claim that the biological mechanisms are sufficiently strong to justify interventions to improve iron status as a means of enhancing human capital.

In a paper published in the *Annual Review of Nutrition*, evidence for the nutritional impairment that helminth infections have on the human life cycle is presented (Crompton and

Nesheim 2002). Included among their topics is that of worker productivity. Citing the work done by Michael and his students, the authors state:

Generally...no doubt all those doing physical work become more productive if they are relieved of hookworms and other infections and given iron supplements and increased energy intakes. A recent estimate claims that the productivity losses attributable to iron deficiency alone in South Asia have a value of ~5 billion U.S. dollars annually.

In the spring of 2002, the annual meeting of the American Association of Physical Anthropology held a symposium entitled *Understanding the linkages between nutritional status, physical activity and productivity*, to honor the contributions of G B Spurr to human biology. Interestingly, to add to the account of Michael's work, Spurr's best-known contribution was his demonstration of a strong positive relationship between nutritional status and worker productivity in sugar cane cutters in Colombia. Among the various papers presented at this symposium was one by Panter-Brick who explores the strategies people use to limit their level of physical exertion and maximize their long-term endurance (Panter-Brick 2003). The theme had been demonstrated by work of Spurr and colleagues who found that people could only sustain a level of physical work equal to 40 % of their maximal capacity (V_{O2} max) during an 8 hour day. They found that in situations where people do heavy physical work on a day-to-day basis, the work they can accomplish is limited by physiological variables. In her paper, Panter-Brick focuses on the role of work intensity and its interplay with the pace of work in varying field situations. She argues that different work contexts, such as a subsistence economy *versus* a wage-labor one, suit individuals better tailored for long term endurance *versus* short term productivity. She calls for more research on work intensity as it relates to objectives for sustainable economic development.

These recent papers corroborate the work done by Michael and his students and colleagues over the years. In a review on nutrition and work performance in Africa, he suggests that contrary to how affluent people usually limit their energy intakes to match their energy expenditure for work, sport, leisure, etc (excluding perhaps joggers or those becoming obese), many poor people with food shortages limit their energy expenditure to match their energy intake, thus forgoing certain activities in order to conserve energy (Latham 1989). The implications of improved nutrition, and consequently improved productivity, to both individual well-being and to the well-being of communities, are far-reaching and cannot be ignored. Michael closes by saying, "A utopian society would provide food and energy to satisfy not only the requirements or needs of all persons, but also for their wants" (Latham 1989).

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Chapter 11 - Advocacy for nutrition

Human rights, globalization and the politics of hunger

In almost all areas of nutrition, Michael has been an advocate in the sense of seeking action to deal with nutrition problems and their underlying causes. In previous chapters, his strong advocacy for breastfeeding, for deworming, for control of micronutrient deficiencies, and so on, is very evident. Unlike many nutritionists, he has consistently believed that nutrition could not be divorced from politics. Alan Berg, chief of nutrition at the World Bank in the 1970s and 1980s, would say that students who came to study in International nutrition at Cornell got both nutrition and political training. Was this criticism? Michael never saw any need to defend that. To use Julius Nyerere of Tanzania's *Arusha Declaration* in a course on International nutrition in the 1970s seemed to him entirely appropriate.

But, separate from advocacy for particular interventions, many of Michael's publications deal directly with human rights issues – the right to food and health, but also children's right to be immunized; to have impregnated bed nets; to be breastfed; and to be dewormed. He also wrote extensively about how westernization and modernization, despite many positive consequences, had also contributed to nutritional problems. More recently, similar writings dealt with economic globalization and some of its negative impacts on nutrition and health. In the human rights movement, he took a strong stand and wrote condemning the use of food as a weapon of war, be it with agent orange destroying rice crops in Vietnam, or the blockade against Cuba, sanctions which harmed civilians, not the leaders or military in any country. His most recent publication deals with children's right to be immunized against measles, to be dewormed, and in malarial areas, to have impregnated bed nets (Latham 2008).

Nutrition and politics

In 1969, a year after he came to Cornell, Michael expressed his views, in the *Lancet*, that nutrition and politics should not be divorced. The article entitled *Starvation of politics, or politics of starvation* became widely quoted. Here are some excerpts (Latham 1969).

The Eighth International Congress of Nutrition, held in Prague a few weeks ago, lasted for eight days; 1600 delegates from many disciplines; and the papers read were as diverse as the nationalities and parent disciplines of those presenting them. Yet at this important congress not only were there no politicians present but politics was almost entirely excluded from the rostrum in each of the dozen or so meeting halls. An occasional pointed question was posed to a speaker and there came from the floor an infrequent quip, which could be called political. These, however, were rare; they were never debated, and chairmen quickly returned the session to a more 'important' topic, perhaps the 'biochemical changes in the skin of the hind leg of cats' or 'ascorbic acid and collagen synthesis in the salmon'.

In one symposium, a speaker from the floor questioned the long-term benefits of food aid to predominantly agricultural developing countries. Food provided through such programmes as that of U.S. Public Law 480, various

philanthropic organizations, and even the World Food Programme might in the short term improve the nutritional status of vulnerable groups in the recipient country, but might eventually prove to be a counterincentive to indigenous agricultural production. It was not uncommon to see in the same harbour of a developing country maize being exported. This type of 'aid' might as a result of subsidies help the U.S. farmer, but was certainly not helping the farmer in the recipient country.

Another part of the article pointed out that hunger in the United States was not on the agenda and little was being written about apartheid in South Africa, while the Nigerian civil war (the Biafran secession) although then on TV screens, was not being looked at in terms of starvation as a weapon of war (Latham 1969).

American workers presented over thirty papers dealing with some aspect of nutritional problems of developing countries; but there was nothing on undernutrition or malnutrition related to poverty in the United States, though Prof. Jean Mayer, special nutrition consultant to President Nixon, did, in the corridors, talk frankly of the immense task facing the new Administration if it is to end hunger and substantially reduce malnutrition due to poverty in the United States.

There were several papers from South Africa, many of them sound scientifically, but none of them facing political issues. There was no mention of the politics that keeps three-quarters of South Africans second-class citizens—a factor which contributes to their ill-health. Nor was there any discussion of the manner in which priorities are set when allocating financial resources for medical work. The cost of the human heart transplant programme in South Africa could provide vaccines for immunisation against common childhood diseases for all Bantu children in that country. Similarly the money spent on a single heart transplant in the United States could perhaps prevent 50 coronary deaths or reduce by a third infant-mortality rates in the poor community of a moderate-sized southern town, if it were allocated for public-health programmes.

We heard a lot about nutritional problems in tropical Africa, but no-one even touched on the malnutrition and starvation in the war-affected areas of *Nigeria*. Is hunger being used as a weapon of war by one side and as a political tool by the other? Is starvation a legitimate weapon of war? In formal sessions these questions were not discussed.

In the article, he went on to regret the absence of China from this Congress (Latham 1969).

One assumes that the absence of China from such a congress was her own choice. However, this was the first international congress of nutrition to be held in a communist country. Did the Prague government make any efforts to get Chinese representation? Has the International Union of Nutritional Sciences, the organizer of these congresses, ever approached colleagues in China? It would be healthy to exchange views and useful to learn something of the nutritional problems and programmes which affect that quarter of the world's population we know so little about.

Michael concluded the Lancet paper with his strong belief that the solution to serious nutritional problems could, and should, not be divorced from politics (Latham 1969).

The solution of the world's nutrition problems depends on political decisions if the results of research in the laboratory, in the hospital, and in the field are to be applied. It is regrettable that nutritionists are not willing to discuss more openly and more formally the politics that profoundly affect the problems they seek to solve. The world's nutritionists are confronted with a choice: the starvation of politics, or the politics of starvation. They must share responsibility for the fact that frequently the wrong political decisions are made. At the 1972 congress, to be held in Mexico City, I hope that political discussions relevant to nutritional problems will not be relegated to corridors, coffee houses, and taverns.

Advocacy from the pulpit – “No man is an island”

Michael has stated that even the most experienced academics who have given many presentations always go to the podium with some nervousness and heart flutters. But he felt much more nervous on March 15, 1981, when he talked from the pulpit to an audience of perhaps 200, than when he had given presentations to audiences of far more than a 1,000 in large convention halls. At the request of the Reverend Jack Lewis, director of Cornell United Religious Work, he gave the weekly Sunday sermon in Sage Chapel at Cornell University, a sermon entitled *No man is an island*, full of advocacy, and concern, for the underprivileged in the world. The sermon, which was subsequently published (Latham 1981), started with a 1624 quote from the English philosopher, sermonizer and fine poet John Donne:

No man is an Island, entire of itself; every man is a piece of the Continent; if a clod be washed away by the sea, Europe is the less, as well as if a promontory were, as well as if a manor of thy friends or of their own were; any man's death diminishes *me*, because I am involved in *Mankind*; and therefore never send to know for whom the bell tolls; it tolls for *thee*....

In the sermon (Latham 1981), Michael went on to state:

The reading from John Donne was chosen because it suggests we live in one world, and that all persons who inhabit it are related and play a role in its destiny. I believe also that most of the people in the world are moral, loving and humane. Although the world basically is a good place, it is today plagued by poverty, disease, and suffering – and yet this need not be. Human actions are at the root of most of the inequity and injustice; and human decisions could change the world into a better place.

If this is to happen there has to be first a better understanding between peoples and second a revolutionary change in attitudes and policies. Without revolutionary changes in our thinking, in our institutions, in the relationships between rich and poor, there is little hope – hope either for the rich or the poor, peoples or nations.

In 1981 we have to be concerned about the enormous ignorance that the United States has for the developing world who form the majority of mankind. Our government and our people appear to fail to understand that the problems of poverty, inequity and injustice in the world are of vital interest to us. A good future for us does not lie in a retreat into either a new militarism or neo-isolationism. As John Donne said, no man is an island, and figuratively no nation is either.

There is always a temptation for us to be satisfied with small steps when giant strides are needed. We require more than palliatives and tranquilizers. Bishop Tutu of South Africa said recently about his oppressed black majority, 'We do not want our chains made more comfortable, we want them removed.'

One of the readings in the Sage Chapel, prior to the sermon, was from Father Dan Berrigan's writings. Dan, a friend of Michael and formerly Catholic chaplain at Cornell University, was arrested and imprisoned several times for 'illegal' acts against nuclear weapons in the United States. Michael's sermon and paper (Latham 1981) went on to state that some seek revolutionary change through the use of arms but:

I much prefer to see change sought through peaceful revolutions. Mahatma Gandhi's approach of non-violence is my ideal. But each human chooses his own weapons. Where are the lines to be drawn? Was Daniel Berrigan's latest act violent or non-violent? Military hardware was destroyed but no life was endangered. The destruction was surely symbolic. Dan Berrigan, former chaplain of this university, has tried to make the world a better place for all people. He has chosen his own means. Our first reading taken from his writings suggests that he sees some Christian qualities in the birds of the sky, and many non-Christian acts perpetrated by humans, some of them professed Christians.

But our press seems to condemn revolutionary violence while condoning institutionalized violence. The use of force by the oppressed against their oppressors seems to be the object of condemnation, while repression of society by recognized governments or by transnational corporations goes uncriticized. And meanwhile institutionalized violence continues. We need to consider how current institutions, supported by our governments, our press, even our churches, our universities and ourselves contribute to poverty, to ill health and to preventable deaths. This different kind of violence is often far more devastating, the carnage is much greater – and usually the victims are those who are innocent, who are not involved, and who cannot defend themselves.

In recent years there have been several reports that look at our world in the year 2000 and beyond, and predict what it will be like. Most of these reports make depressing reading, because the prospects do not look good. The world will be more crowded and more polluted, there will be a greater gap between rich and poor, and there will be more hunger and malnutrition. But as a nutritionist and doctor, let me stress that the huge problem of hunger and malnutrition is not due to some uncontrollable act of nature – it is not mainly the result of drought or poor soil or low productivity – it is an act of people. There is enough food in the world today to feed the whole world population, and there will be enough food in the year 2000 to feed the six billion people who will be present then. The problem is not now one of inadequate production of food, but is one of inadequate distribution. And by distribution we are not talking about food hand-outs, but about policies that influence purchasing power, prices, food allocations, and questions of politics and control. These are problems that humans could solve quickly for the benefit both of the rich and the poor. There is no real need for the U.S. to feed more than half of its cereal grains to animals and there is no necessity for the Philippine government to export 1,000 Calories *per head per day* of sugar and coconut oil to the industrialized countries, while more than half their own children are undernourished.

We must stop supporting anti-democratic regimes like that in Nicaragua under Somoza in the past and that in Chile under Pinochet now. We need a new economic order in which fair prices are paid for the primary commodities such as for example, sugar and bananas, copper and tin from the developing nations and we must pay adequately for the labor of poor countries. Billions of dollars now spent on offensive weapons and on military assistance have to be diverted to humanitarian projects in agriculture, in health, in transportation, in land reform and in social development. If just 5 percent of the military budget of the industrialized countries (both capitalist and communist) were transferred to development assistance in the poor nations we could transform the quality of life in those countries before the turn of the century.

In the sermon, Michael went on to provide three examples of the human spirit, personally experienced examples, which illustrate the reaction of humans in the face of suffering and crisis (Latham 1981). He did this to illustrate that the world is made mainly of good caring people and concluded with these words:

Lincoln once said 'No country can exist half slave and half free'. What he said then about his deeply divided country is equally true of our deeply divided world today. Peace is not possible while the majority of mankind lives hungry, poorly housed, riddled with disease and in squalor, while the rich minority simply ignores their plight, continues to squander the world's scarce resources and prays to the false gods of consumer technology and militaristic power.

It took less than the cost of one U.S. bomber finally in 1979 to rid this planet of smallpox, for centuries a dreaded lethal disease. Let us address ourselves to some other of these kinds of problems, while at the same time raising the quality of life for all humans.

There is hope for the world if we accept that people, small people, matter and make a difference. The problems of population, disease and hunger can be overcome if we address ourselves to their underlying causes, which are poverty and inequity. And of course, the poor nations need to help themselves and contribute substantially to their own development.

A revolution is needed in the attitudes and views of the 'haves' in relation to the 'have nots'. The world, with the help of men like William Wilberforce and Abraham Lincoln, got rid of one kind of slavery, surely it is possible in the next few decades to rid the world of its modern slavery.

We are indeed one world and let us remember the words of John Donne:

Never send to know for whom the bell tolls, it tolls for thee.

Hunger in America

Chapter 4 in this monograph, entitled *Hunger in America – Research and Advocacy*, clearly summarizes Michael's opinions on undernutrition and food programs in the United States. His rather frequent testimony before committees of the United States Senate and House of Representatives are testament both to his advocacy and to his belief that political action is vital to improving the nutritional status of Americans. The focus has now rightly

moved to prevention of chronic nutrition related problems like coronary heart disease, obesity, hypertension, diabetes, and cancer. As mentioned in chapter 4, Michael was also part of a research team investigating arteriosclerosis in the 1960s, and he currently has a Ph.D. student, Edward Jones Jr, studying adolescent obesity in the US Virgin Islands. Although most of his research, and that of his students, was conducted in non-industrialized countries, he has frequently, in both testimony and writings, linked nutritional problems in the United States to politics. Here is an example taken from a paper prepared for the US Senate Committee Nutritional policy hearings in 1974 (Bode, Gershoff and Latham 1974).

Although it is true that there is little evidence of many of the forms of acute malnutrition in the United States, many children exhibit poor growth and development due to poor nutrition, and infant mortality associated with low birth weights is higher in the United States than in many other countries. Furthermore, one can easily demonstrate evidence of problems of undernutrition. For instance, there is considerable anemia due to deficiencies of iron, folic acid and other nutrients. Dental caries due to low ingestion of fluoride and the consumption of cariogenic diets is almost universal, and goiter is once again becoming a problem. The results of scientific studies of the nutritional health of Americans consistently indicate that many people eat diets which are inadequate in essential nutrients and that many exhibit unacceptable biochemically determined values for nutritional adequacy. Of considerable concern is the observation of the USDA, supported by independent observations throughout the United States, that the quality of the American diet with regard to the ingestion of essential nutrients decreased during the 1960s.

Since World War II there have been hundreds of studies done of the nutritional status of Americans. These have included dietary, biochemical and clinical assessments... What is of particular concern to us is that results of the most recent studies add little to our knowledge and completely ignore questions which we feel must be answered if the United States is to develop a sane and equitable nutrition policy. The questions which have not been asked concern the ways in which income directly affects what people eat, how often they eat, what they may sacrifice in order to eat, and how all these patterns change in response to variations in available income or food programs.

We have not asked, for instance, whether people buy some kinds of foods at the beginning of the month and other kinds (or no food at all) at the end of the month when resources run out. We have not tried to measure how this 'end of the month' syndrome affects overall nutrition. We have not collected enough information on the kinds of tradeoffs low-income people are forced to make in their family budgets between medical care and food or food and rent. We have some idea that inflation affects low-income consumers disproportionately, but no understanding of how severely this affects nutrition.

The questions have not been asked because malnutrition has been poorly defined by most nutritionists and public health officials with the result that most studies of the nutritional status of Americans have been incomplete, concerning themselves exclusively with the intake of a limited number of individual nutrients, a small number of biochemical indices, and occasionally with the appearance of clinical signs of malnutrition.

In America in 1974, a person should be considered malnourished if for economic or other reasons beyond his control he experiences repetitive periods of prolonged hunger even though his total intake of nutrients is sufficient to protect him from symptoms of deficiency disease. We believe that significant numbers of people in the United States suffer from this type of malnutrition. They can be found among the poor whose resources for acquiring food regularly run out at the end of each month. There is no difficulty in finding people who cannot feed themselves or their children adequately during the last few days or week of each month. Among the elderly the lack of money is compounded by difficulty in shopping caused by infirmity or, in many cities, fear of assault. We have observed hunger in school children who do not eat breakfast and who do not have an available school lunch program. These children may meet their nutrient requirements with an after-school snack and a large evening meal but sit in school hungry every day. Such individuals are malnourished, and information concerning the number of people who experience repetitive hunger of these types is urgently needed (Bode, Gershoff and Latham 1974).

Banning food as a weapon of war

Michael was a founding member of the World Alliance for Nutrition and Human Rights (WANAHR) based in Oslo, Norway, and has been a very active member of the alliance. WANAHR played an important role in focusing attention on the need for actions to allow most people in the world to enjoy their rights to adequate food and good nutrition. Within the broad context of the right to food, Michael has often focused on the use of food as a weapon as a very basic human rights issue. In the prologue of the WANAHR bulletin he edited in 1998, Michael wrote (Latham 1998):

We are committed to the belief that access of all humankind to an adequate diet, that is an adequate quantity and quality of food to satisfy both energy wants and nutritional needs, is not an act of grace, but is a human right. The 1948 Universal Declaration of Human Rights, and the 1966 Covenant on Economic, Social and Cultural Rights, established the right to food. The Declaration states that 'everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food'. The Covenant elaborates on the words in the Declaration by recognizing 'the fundamental right of everyone to be free from hunger'. The 1989 Convention on the Rights of the Child addresses the well-being of the world's children, and stresses legal aspects and specific objectives to ensure adequate food and good nutrition for the world's children. The World Food Summit held in Rome in 1996 re-emphasized that the nations of the world and their leaders from north and south support adequate food as a human right. The Summit dealt extensively with questions of food security for all.

The major factors which impede the realization of food and nutrition rights are political and economic, factors which are closely linked. There is enough food in the world to provide an adequate diet to all human beings on earth, and yet hunger and malnutrition are extremely prevalent. This is often because the poor cannot afford to purchase enough food for family needs, and poverty contributes to health problems which can lead both to malnutrition and to poor care for children. Political action, or inaction, prevents large percentages of the population from raising themselves out of poverty.

How will governments, international agencies and civil society move forward to ensure that all humans enjoy their rights to food and good nutrition? At the international level, the increasing power and influence of transnational corporations, globalization, so called free trade, structural adjustment, and weakening of the state *versus* strengthening of the marketplace, are contributing in many countries to more hunger and malnutrition, and to a wider gap between rich and poor, nations and people.

It is not easy to be optimistic about international or national actions that will be taken and sustained in the next decade to allow most people in the world to enjoy their rights to adequate food and good nutrition. However there is one particular area of nutrition and human rights where major progress could be made very quickly and at very low cost. This would be if the nations of the world and all people would adhere to international agreement to ban the use of food as a weapon of war or for political purposes.

A recent editorial in The New England Journal of Medicine stated that 'economic sanctions are, at their core, a war against public health'. The writer goes on to point out that the professional ethic of physicians 'demands the defense of public health'. Thus, as physicians we have a moral imperative to call for the end of sanctions.

Germ warfare, it is claimed, was banned through international agreements, because it is indiscriminate, and is likely to kill civilians, not just armed forces fighting in wars. Food used as a weapon causing starvation is not entirely indiscriminate. It seldom seriously harms the armed combatants or political leaders, but rather affects preferentially, and causes malnutrition, starvation and death in children, the elderly and women. Surely this is an argument for implementing a ban on the use of food as a weapon, and for stringent condemnation wherever this ban is infringed. The international outrage against those using food as a weapon should be just as loud as against the use of gas or germ warfare.

Whereas banning the use of food as a weapon of war is relatively clear-cut, the use of food as a political weapon is not. There are some rather clear instances and others that are more indirect or fuzzy. Here we are concerned mainly about the (Latham 1994a)former. These are for example blockades such as now in Cuba and Iraq; deliberate destruction of food or food crops such as the use of herbicides in the Vietnam war; and actions deliberately to prevent people from having reasonable access to food (Latham 1998).

In a former paper, Michael had examined earlier conventions related to the use of food as a weapon of war and had stated:

Many conventions and protocols address wartime abuses of human beings or the environment, and many of these mention the right to food. As far back as 1897, the Hague Convention stated that 'the right of belligerents to adopt means of injuring the enemy is not unlimited'. The Additional Protocol of 1977 to the 1949 Geneva Convention used these words:

Starvation of civilians as a method of warfare is prohibited... and ...it is prohibited to attack, destroy, remove, or render useless objects indispensable to the survival of the civilian population, such

as foodstuffs, agricultural areas for the production of foodstuffs, crops, livestock, drinking water installations and supplies, and irrigation works.

These protocols also address the question, and seek to lay down principles, that allow organizations to provide food to groups of people suffering from hunger.

A related but somewhat different issue is the attempt to go beyond 'war' however defined, to the broader attempt to outlaw the use of food for political purposes when it is likely to have negative nutritional effects on civilian groups. The aim is to prevent the use of food as a deliberate strategy, when that strategy will clearly have a negative impact on the nutritional status or health of children, women, the elderly, or other vulnerable groups (Latham 1994a).

In the article, he went on to give in detail some recent examples of food being used as a weapon of war or for political purposes (Latham 1994a). One example was the US embargo and blockade of Cuba:

For some 30 years the United States has implemented a strict embargo on Cuba, simply because the United States has not wanted a communist regime in the western hemisphere. Whether this was popular with Cubans or not was of no concern to Washington policymakers. The policies of the Castro regime, following years of right-wing dictatorships, resulted in remarkable reductions in infant mortality and improvements in health and education for the Cuban people. This seems unimportant to U.S. decision makers, either Democrat or Republican; for not only does the United States not trade with Cuba, it uses every effort to prevent other nations from trading with Cuba. The United States has been particularly effective in this regard, with its many client states in the Americas.

The embargo against Cuba is aimed at creating hardships that will lead to a change of leadership. The aim in Cuba is to bring down Castro and his regime and replace it with one that is non-communist and friendly to the United States. But the main impact is on ordinary people.

With the collapse of the Soviet Union - and the loss not so much of financial assistance but of trade with the U.S.S.R.- Cuba has entered into a very serious economic crisis that is having devastating effects on ordinary Cubans. There are now real shortages of food and health services; including essential drugs and supplies. Low infant mortality rates and child health that were once the envy of Latin America are now threatened. In June 1993, a delegation sponsored by the American Public Health Association visited Cuba, in part to focus on the impact of the recently tightened U.S. economic embargo. Their summary report states that,

The food supply has diminished, and the Cuban diet is much less adequate than before in both quality and quantity. Medicines of all kinds and medical supplies are scarce. One devastating effect of the U.S. embargo is the interference in Cuba's access to food and medical products. All this has threatened the health of the Cuban people.

The report goes on to quote the words of the APHA spokesman at a 1993 US Senate committee who states that the embargo's

interference in the Cuban people's access to food and medicine is tantamount to the use of food and medicine as a weapon in the U.S. arsenal against Cuba.

The report goes on to state:

Earlier this year a bewildering medical condition struck many Cubans. The diagnosis was of a type of ocular neuritis, which caused serious illness, and in some cases blindness. Despite investigations by Cuban physicians and visiting U.S. medical teams, the etiology of this condition remains unknown. It may be nutritional - due mainly to B vitamin deficiencies, particularly deficiencies of thiamin and pantothenic acid. Few observers agree about the exact etiology, but all seem to agree that the worsening situation in Cuba with regard to food, medical supplies, and other essential products has contributed to the mysterious disease.

The U.S. embargo against Cuba violates both that country's human rights and international law. Washington continues to hold hostage the health of the Cuban population for political purposes. This is immoral, unethical, and illegal. The economic embargo has been described as an 'inhuman form of warfare - it targets people, especially kids.

Human rights organizations and concerned individuals from all nations must mobilize to ban the use of food as a weapon of war and end the use of food as a political weapon where it will cause harm, including malnutrition and hunger, for significant numbers of civilians (cited in Latham 1994a).

In 1994, at the invitation of the Cuban government and the Pan American Health Organization (PAHO), Michael participated in a small five-day conference held in Havana to attempt to reach conclusions on the actual cause of the serious epidemic of a neuropathy which resulted in optic neuritis as well as debilitating neurological symptoms including ataxia. President Fidel Castro attended many sessions of the conference. At the conference, Michael presented his findings from a similar neuropathy which he had investigated in Tanzania many years earlier and had proved to be nutritional in origin (Latham 1964). The unusual neuropathy in Tanzania had occurred in men confined to prison and fed a food ration. The epidemic neuropathy in Cuba occurred almost entirely in adults consuming a ration which had been reduced because of the US embargo on that country (Latham 1994b). In this *Lancet* paper, Michael concludes that the Cuban epidemic was of nutritional origin.

Smallness – a sign of earlier deprivation

In the mid 1980s, and perhaps every decade, a debate unfolds on the issue of 'smallness' and its relationship to health. This refers to small in stature, not in girth. There is no disagreement that obesity, and marked overweight is unhealthy. In Chapter 2 of this monograph, the early work of the Cornell group leading eventually to classification of malnutrition based on anthropometry of children is discussed (Seoane and Latham 1971).

With a debate raging, both in the world press, and in the scientific literature, the issue of 'small but healthy' and 'smallness as a sign of earlier deprivation' became an advocacy issue (Latham 1984). Following are some quotations from an Editorial in the *Lancet* (Anon 1984) which discusses the use in developing countries of international growth standards:

...recent evidence suggests that the growth of privileged groups of children in developing countries does not differ importantly from these standards ... and that 'the poorer growth' so commonly observed in the underprivileged is due to social factors - among which the malnutrition - infection complex is of primary importance - rather than to ethnic or geographic differences.

The new evidence referred to in this editorial is in part based on work conducted by us in Kenya (Stephenson, Latham and Jansen 1983). Our analyses show first that most standards in use in recent decades give closely comparable results, and second, that in Kenya the underprivileged children, with poor diets and many infections, grow much more poorly than do the privileged East African children from similar ethnic backgrounds. In the *Lancet* editorial (Anon 1984), the author goes on to say 'the Cornell group also reports that their studies of privileged and non-privileged children in Kenya support the view that social factors, rather than ethnic background, are responsible for the differences in growth'. New data therefore very strongly uphold the view expressed by JP Habicht a decade earlier that 'height and weight of pre-school children in several developing countries were much more strongly influenced by social factors than by ethnicity' (Habicht, Yarbrough, Martorell, Malina *et al.* 1974).

The evidence from most countries, including from our work in East Africa and many studies conducted in India, is that most of the growth retardation due to adverse dietary, social, and health conditions occurs before children reach 4 years of age. In many poor communities where breastfeeding is widely practiced, the period when the greatest slowing of growth occurs is between 4 and 36 months of age.

Therefore 'small' Indians, and 'small' groups of people in other countries, who are over 4 years of age, are often 'small' because of events that happened in their early life. A variety of adverse factors over long periods of time prevented proper nutrition at the cellular level. These groups of 'small' people have the permanent scars of past malnutrition or undernutrition. If weighed and measured, they are lighter and shorter than the standards. They are stunted or have evidence of past chronic malnutrition (Seoane and Latham 1971). These older children or adults may, or may not, have a lower weight than that expected for a person of their height (a low % weight-for-height). If they are underweight in relation to their height, they are thin, and are defined as wasted or as having evidence of current (or acute) undernutrition.

In the editorial, the author goes on to dispute the frequently stated concept that 'smallness is a desirable attribute' (Anon 1984):

But the important point to appreciate is that the stunted, the dwarfed, the small individuals who have no current evidence of wasting, do show evidence of poor diets and ill health in early life. And these insults which have left permanent scars or sequelae were preventable, and deserve preventing. It should be noted that this discussion refers to groups of persons. There are, of course, some individuals

who are dwarfed or small due to other causes, including genetic or metabolic reasons, and there is a recognized range of differences in anthropometric measurements for normal people.

We do not dispute the fact that genetic factors influence the final stature of individual adults and of certain ethnic groups. The potential for growth for Indians may be different from that of Eskimos, or Japanese, or Norwegians. Certainly the differences in stature of the pygmies and the Watutsi both living in Central Africa appear to be due in part to genetic factors. But an examination of growth data from many countries suggests that in groups of young children much larger differences are due to deprivations than to inheritance (Anon 1984).

Recent research supported by the World Health Organization has led to a new set of growth standards for infants (de Onis, Garza, Onyango and Martorell 2006). The results established that healthy breastfed infants from poor developing countries grow exactly at the same rate as breastfed infants from northern industrialized countries. As one of the authors said verbally, 'we find that Norwegian infants grow almost as well as Indian children'. The previously used standards, which are now being abandoned, were based on 'formula fed', often overweight infants, in the United States.

Inappropriate modernization and westernization as contributors to malnutrition and ill health

For many years, Michael has written and lectured about how certain aspects of 'modernization' and of 'westernization' have contributed to malnutrition and ill health. Examples which he saw before becoming an academic, and later wrote about, were formula feeding replacing breastfeeding; sodas and sugary manufactured foods contributing to dental caries in Tanzania while their costs and empty calories contributed to malnutrition; the spread and new popularity of heavily milled corn (and other cereals); and the promotion of cigarette smoking.

Michael presented a detailed analysis and review of inappropriate modernization at a workshop on *Hunger and Society* held in Iringa in Tanzania in 1983 (Latham 1988). As chair of the workshop, Michael prefaced the three monographs emanating from the meetings and described their nature and the broad level of agreement of the 20 rather carefully chosen participants (Latham, Bondestam, Chorlton and Jonsson 1988):

The workshop, where the papers in these three volumes on 'Hunger and Society' were first presented and discussed, took place at Soliwayo in the Wanging'ombe division of Iringa region of Tanzania in December 1983. The meeting was the brainchild of Urban Jonsson, the UNICEF representative in Dar es Salaam. It was organized and sponsored jointly by UNICEF and by the Tanzania Food and Nutrition Center (TFNC). Dr. T.N. Maletnema, the managing director of TFNC, and Dr. Jonsson, invited the participants after circulating a conceptual framework on hunger and society to a number of scholars worldwide, and receiving some feedback.

The 20 participants, persons from many different countries, left their comfortable residences to spend about ten days together mainly in a rural setting in Tanzania, where we had a variety of experiences. Together in Dar es Salaam we

helped celebrate the tenth anniversary of TFNC; in Iringa we heard Prime Minister Edward Sokoine of Tanzania at the opening ceremony for the newly launched Joint Nutrition Support Program talk in eloquent Swahili on the virtues of growth monitoring, oral rehydration, breastfeeding, and immunization, while Jim Grant, executive director of UNICEF, looked on, quite spellbound; we met on five consecutive mornings for four or five hours to discuss papers we had prepared on Hunger and Society, adjourned for a late lunch in a different village each day to eat local food, to hear about village plans and problems, to view various development activities, and to join in traditional dancing; and for the rest of the day, often late into the night under clear brilliant skies, had further discussions on conference topics; and we held a final one day session in a tented camp (after an animal viewing excursion near Mikumi), where a decision was made to publish these papers.

For me those ten days were rare, and memorable. When the participants bade farewell to their local hosts and village leaders there were literally tears shed by even hardened conference goers. A few days, a great deal of camaraderie, strong feelings expressed, and a common sharing by people of very different cultures, class and education had moved us all. I had the somewhat utopian feeling that if this band of world citizens were running the world; were in the Kremlin, the White House and State Houses in the South; then the world would be a better and safer place in which to live—and one where hunger in society would soon be unknown.

The difference between this, and other such conferences, was not mainly in its setting in a rural village, not a luxury hotel, nor in its format and subject matter. It was rather in the shared values of almost all the participants. We were not all of one political persuasion, but we did not disagree much about the fact that inequity and poverty were at the heart of hunger in society. We shared many of President Julius Nyerere's strongly expressed views on north-south problems and therefore felt that Tanzania was a good venue for our meeting; and we all recognized that to reduce hunger much more was needed than increased national levels of food production and mainstream macro-economic solutions as suggested by such bodies as IMF (Latham, Bondestam, Chorlton and Jonsson 1988).

In his paper on inappropriate modernization (Latham 1988) Michael wrote:

It has been argued that development theories accumulate rather than replace each other and that, for example, many elements of the growth and modernization school are still evident in the thinking of those supporting the newer schools of development. The term 'westernization' is also difficult to define and therefore is often misused. Because the most recent writings tend to divide the nations of the north from those of the south we may be more correct now in talking of northernization rather than westernization. But in general westernization or northernization implies the influence of European and North American values on other countries and cultures.

Even if we cannot agree on what development or westernization means, all will appreciate that development involves change—cultural change, social change, economic change, political change, and even change in values. When any of us suggest change or influence it we should surely consider very carefully whether that change is for the better. We must be concerned with whether the change will improve the quality of life of people. But too often programs and actions foster change for change's sake, or individuals try to influence change to get others to be

more like themselves, or agencies implement projects that involve change both without considering the implications in terms of quality of life and with a naïve assumption that all new structures automatically provide benefits. Let me illustrate this with an anecdote.

When I was doing nutrition work in Tanzania some years ago, we had a visitor who was a world-renowned fisheries expert. One day after lunch I took him to a fishing village. We stopped and talked to an old fisherman, who was relaxing under a coconut palm looking out onto the coral reef and the beautiful Indian Ocean beyond. The visitor asked me to serve as interpreter while he questioned the fisherman. 'Why aren't you fishing this afternoon?' the visitor asked rather sharply. 'Because I caught six quite large fish this morning and that is sufficient for me,' replied the fisherman. The expert suggested to him that if he fished also in the afternoon he would have caught perhaps 12 fish. 'But what would I do with 12 fish?' the old man responded. 'You could sell them, and earn money to buy a new net,' replied the expert looking disdainfully at the torn cotton net at our feet, 'and with a nylon net you'd catch far more fish'. Looking somewhat bored the fisherman again replied, 'And what would I do with all these fish?' 'You could market them, and in a few months you'd have finances to buy a good boat that could go far beyond the reef, and get rid of your old dug-out canoe,' said the visitor pointing at the old ngalawa, which was lying on the beach in front of us. This conversation went on until the expert had the fisherman with a new fiberglass boat, several nets, and a modern Johnson outboard motor.

'And what would I do with all these fish?' was the constant response of the fisherman. Now the expert looked pensive. He provided his final winning comment (after all he was an intelligent, civilized man). 'In a year or two, old man, you would be earning enough money to allow you to hire someone else to fish for you. And then you would be able to take some rest in this beautiful place.'

'That is just what I am now doing,' was the immediate response.

This tale illustrates the desire of the western expert to foster change, convinced that it will improve life. But many businessmen caught up in the rat race in western cities are scrambling to make enough money to allow them to spend a few weeks each year on a tropical beach. There are many nonwestern people sitting under palm trees. And the executive is very likely to have a heart attack in middle-age as he fights the traffic, the snow, and the smog to earn his living and his vacation. Who has the better quality of life?

But except for a small band of anthropologists and some others influenced by Rousseau's concept of the 'noble savage' there were few people in the 1960s who dared doubt that major capital projects such as the construction of huge dams or palatial multistory hospitals were anything less than clear evidence of progress and signs of development. And the assumption was made that these handsome new structures were of benefit to most people. Even if views have changed somewhat, there are few western economists who do not - at least in their closets - pray at the altar of growth; unfortunately their god is economic growth rather than child growth.

It is, of course, dangerous to glamorize life in the villages of developing countries; for many poor people's life is extremely hard, much of their day is spent doing unpleasant things, and their sufferings are often severe. There is no doubt that better housing, improved health, a greater variety of social activities, better communication, and of course, an adequate level of food consumption, are strongly felt needs of almost all poor people everywhere. And so the East African fisherman living in an idyllic environment is not necessarily living the good life. The argument being made in this chapter is not to oppose modernization or development, but rather to recognize finally that all modernization and all development efforts do not automatically provide benefits for the poor, and secondly that such actions sometimes have adverse effects on the quality of life of poor people. While acknowledging that there are often benefits to be had from westernization and modernization, this chapter will show that there are sometimes negative effects which at the very least require recognition.

The major problem for the non-oil-producing, non-industrialized countries of the South is surely the current economic order, or disorder. Quite simply the countries are not being adequately or fairly paid for the primary products that they produce and export. If the prices of say coffee, tea, sugar, copra, sisal, bananas, and cotton, and of certain minerals such as copper had been tied to the price of oil, or even to the world price of automobiles, then few developing countries would need any foreign assistance at all. Not only do the countries of the South suffer under these unfair price structures, but they have absolutely no control over them. The prices are said to be a reflection of the free market system and of supply and demand. But in fact they are manipulated by the industrialized countries and by the multinational corporations in a manner that usually depresses the prices of those primary products produced mostly by the developing countries.

If the prices of these products were just and equitable, then the economy of most developing countries would not now be in such disarray. But to benefit people, the more-equitable prices would have to accrue to the primary producers, and not as now mainly to the middlemen, the traders, or the governments. I live in a rural apple-growing county in western New York State. In the local shops apples sell for 60 cents a pound and bananas for 35 cents. Clearly this is not only absurd, it is exploitative, when we consider how far that banana has traveled and how little of that 35 cents goes to the banana grower.

It is simply unfair that Tanzanian farmers producing cashew nuts or a Nicaraguan peasant producing coffee in 1987 can purchase so much less of their meager market needs than they were able to purchase for an equal amount of produce in 1977. Each year the primary producers have to sweat that much more to purchase one liter of oil for their lamp or a new sheet of corrugated iron for their roof. This important issue of unfair prices has been cogently addressed by President Nyerere of Tanzania and by others. But the system seems immutable.

To suggest that westernization, modernization, and certain development projects may have negative effects, is contrary to much that is published on the subject of development. It goes against the written project plans of international and bilateral agencies, which suggest that their projects for modernization and westernization are essential components of development and the necessary basis for a reduction of hunger and malnutrition. This is not always so. The transfer and adoption of certain alien ideas, namely that the promotion and use of particular

modern technologies and the introduction of certain western and capitalist development strategies, are not always the best solutions to nutritional and health problems in nonindustrialized countries.

There are good examples to show that they are often, in fact, the cause of such problems. It is not suggested that change is necessarily bad and should be avoided, nor that all new technology is undesirable, or that a particular political system offers the only solution to hunger. Change is inevitable and is necessary for the improvement of nutrition and health. Modern knowledge and certain new technologies can be harnessed for the good of the poor, and each country should be allowed to choose freely its own political system. But, when change is encouraged either by outsiders or by governments themselves, it is very important to consider the possible adverse effects of the changes being promoted. The question everyone should ask is, 'Will the change improve the quality of life of most people affected?' Perhaps a nutrition and health impact statement should be required of all new projects before implementation, in the same way that 'environmental impact statements' are now required. All should question whether there may be adverse effects, and, if so, who will suffer most from them.

Examples of changes that have negative effects on nutrition and health that are discussed below include: serious problems associated with the spread of bottle-feeding and infant formulas and the decline in breastfeeding; the move from food crops for home consumption to cash crops to earn money; the Green Revolution with its benefits and problems; the use of highly milled cereals in place of lightly milled or home-pounded grains, sometimes accompanied by a loss of jobs; the spread of bottled, sugary beverages, sweet foods, and cigarette smoking and their effects on health; the role of new dams in increasing the prevalence of certain tropical diseases; and certain negative effects of other aspects of development (Latham 1988).

In the section of the paper (Latham 1988) headed *Sugar, soda, and smoking* he stated that:

... most evidence suggests that changing dietary practices, the adoption of western diets and especially the greatly increased consumption of sucrose-containing foods (sweets or candy, biscuits or cookies, etc.) and soft drinks or sweet sodas are leading to major increases in dental caries in many countries. Frequently this is evident first in the urban areas and then spreads to the rural population. There are also nonindustrialized countries where sugar consumption is high and dental caries rampant. For example, in Colombia *panela* (dark brown sugar) and *panela* water are commonly fed to infants and young children. Dental caries there is prevalent.

It is evident that modernization and westernization have influenced these changes. Many of the influences that have led to the switch from breastfeeding to bottle feeding are also at play increasing the consumption of sodas containing sucrose. Hard sell advertising, the use of other promotional activities, the belief that it is prestigious and modern to consume sodas, as well as other factors, have influenced this change.

In many developing countries tobacco chewing and smoking became popular with certain groups of the population long before hard sell techniques were widely used to promote cigarettes there. But the rapid increase in cigarette smoking in the nonindustrialized countries has been influenced by the same kinds of sources that have led to a high use of infant formulas and sweet sodas. Again the profits of

multinational corporations have taken precedence over the health of people. Unlike most of the other examples the negative results affect the rich as much as the poor, although the former can better afford the medical treatment that may be needed once a health problem arises.

The people of the developing countries are the new targets of promotional drives by cigarette manufacturers whose interests are vested in increased consumption. The British American Tobacco Company (BAT), for instance, now has subsidiaries in 180 countries. A rapid rise in tobacco consumption is now taking place in developing countries and tobacco-related diseases are on the increase (Latham 1988).

Many of the examples discussed in the article have features in common; they may produce benefits to some and harm to others; and they have sometimes been introduced in the poorer countries of the South without adequate consideration of possible negative impacts. Some cases illustrate the role of transnational corporations ready to make a profit, with too little concern for the problems of the consumer, and in not a few examples, medical or other highly trained professionals, are parties to the introduction of change that may sometimes cause harm.

Economic globalization and inequity as determinants of malnutrition

Globalization is difficult to define and it takes many forms. Many aspects have a generally positive impact on the populations of our world. Some aspects of 'economic' globalization have been shown to have a negative impact on the underprivileged populations in non-industrialized countries. Harsh capitalism, including neo-liberal policies, the rather free reign given to Transnational Corporations (TNC), and the current world economic order, all contribute to growing inequity – the rich get richer, both countries and people. And inequity leading to poverty is a major cause of undernutrition and hunger in the world.

Discussion and analysis of these, and related issues leading to advocacy and action, are needed in the battle to reduce malnutrition worldwide. In an invited article entitled *Globalization and inequity as determinants of malnutrition: a clear need for activism* Michael Latham and Micheline Beaudry examined and reviewed this issue (Latham and Beaudry 2001). In the abstract they state:

Attempts to reduce food insecurity and malnutrition have generally concentrated on food availability rather than on food demand, and on technical solutions such as micronutrient fortification and supplementation rather than on improving equitable access to adequate food, health and care. Relatively little attention has been devoted to important external determinants such as globalization and actions of transnational corporations (TNCs). In the last two decades, inequity has greatly increased with a widening gap between rich and poor, while globalization has been offered as the answer to improving the economics of poor countries. Much power has been moved to the marketplace and to TNCs who are neither adequately regulated nor accountable to national governments nor their citizens. It is important that nutrition scientists study these issues, and link up with other activists working to reduce inequity, oppose harmful aspects of globalization, and reign in the power of

TNCs. Activism has previously achieved some successes, notably in countering the unethical promotion of breastmilk substitutes.

What is economic globalization? According to (Mander 1996) it involves

... the most fundamental redesign of the planet's political and economic arrangements since at least the Industrial Revolution. Its deep underlying ideological principles include the primacy of economic growth; the need for free trade to stimulate the growth; the unrestricted 'free market'; the absence of government regulation; and voracious consumerism combined with an aggressive advocacy of a uniform worldwide development model that faithfully reflects the Western corporate vision and serves corporate interests.

Michael Latham and Micheline Beaudry go on to write (Latham and Beaudry 2001):

The 1999 Human Development Report (UNDP 1999) underlines that while many countries since the 1980s have seized the opportunities of economic and technological globalization, many others have become more marginalized and show little benefit from expanding markets and advancing technology. More than 80 countries still have *per capita* incomes lower than they had a decade or more ago and 55 have had declining *per capita* incomes.

....

The following further illustrates global disparities (and absurdities!):

- The assets of the three richest people in the world in 1998 were more than the combined GNP of the 48 least developed countries.
- Americans annually spend more on cosmetics (\$8 billion) and Europeans on ice cream (\$13 billion) than it would cost to provide basic education or water and sanitation to the more than 2 billion people worldwide who go without schools and toilets.
- A yearly contribution of 1% of the wealth of the 200 richest people could provide universal access to primary education for all (\$7 to 8 billion). Between 1994 and 1998, their net worth increased from \$440 billion to more than one trillion!.

The Human Development Report (UNDP 1999) concludes:

Globalization expands the opportunities for unprecedented human advance for some but shrinks those opportunities for others and erodes human security. It is integrating economy, culture and governance but fragmenting societies. Driven by commercial market forces, globalization in this era seeks to promote economic efficiency, generate growth and yield profits. But it misses out on the goals of equity, poverty eradication and enhanced human security.

.....

Worldwide the 15 largest TNCs (such as GM, IBM, Shell, Nestlé) have gross incomes larger than the GDP of over 120 countries, including all countries in Africa. Close to two-thirds of world trade is controlled by TNCs; one-third of it consists of intra-firm transactions, that is IBM trading with IBM, Cargill with Cargill. Cargill

controls 60 % of world grain trade and three companies control 88 % of the banana market. This concentration is rapidly increasing with the flurry of recent mergers. The public sector has been conquered by the corporations, who in one sense compete, but in others unite in a strong front to weaken government power, and in a deliberate effort to put profits ahead of the public good.

This devolution of power from elected governments to the market is evident in northern industrialized countries and in poor developing countries.

The paper continues with a discussion of differing models within democratic capitalist countries (Latham and Beaudry 2001).

Is economic advancement dependent on a dismantling of free, or subsidized, social services including in education and health, and the rejection of social democracy? Norway is one country that has successfully maintained social democracy in the world of globalization. While having high unemployment pay, strong acceptance of trade unions, generous maternity leave that also protects breastfeeding, excellent universally available health care and education, and good pensions for the elderly, it has very strong economic growth, low rates of unemployment, wage moderation and a fair degree of price stability. At the same time it leads the way in percentage of women in parliament, the cabinet, and in senior positions, very strong environmental policies (except its support for whaling), and excellent record on human rights, generous support for developing countries, and lately it has played an often pivotal role in international peacemaking.

Should Norway be the rule, not the exception? Are there not lessons to assist developing countries raise themselves out of poverty while also recognizing the importance of improved equity especially in terms of access to education, health care and opportunity? Perhaps democratic countries in the South need to consider a choice of models between Scandinavia (or Canada!) and the United States. This is often put in political ideological terms of socialist versus capitalist. But Scandinavian countries are really capitalistic; and the U.S. has a free socialist education system up to and including high school. In Norway and Sweden, most people are pleased that their strong democratic governments have a large influence on their lives whereas apparently the majority in the United States want a minimum of state control. In consequence there is a private health care system with millions having no health insurance; no mandatory maternity leave and abysmally low rates of breastfeeding; corporations have more influence than the government on ecological issues; and inequity gets greater each year.

A strong government is more likely to be able to resist actions by large TNCs, when these may have a negative impact on the health, nutrition and well-being of the poor. Of course, a strong and independent civil society is an important and necessary support for such government action (Latham and Beaudry 2001).

In their conclusion the authors state (Latham and Beaudry 2001):

Inequity is a major determinant of food insecurity and malnutrition. Current world economic policies, pressure for globalization, and the increasing power of TNCs all appear to contribute importantly to this increasing inequity and the parallel weakening of the state. To our knowledge, there is no analysis which directly links the many new facets of globalization and the role of TNCs to their impact on

nutrition. However, the evidence presented suggests that their recent development and evolution has generally been accompanied by increases in poverty and in inequity, as well as persistent food inadequacy. This has happened while food production and availability have improved and are generally adequate at least to cover energy needs of the population in all continents except in Africa. While much of the current evidence of the negative impact of globalization and many TNCs on food security and nutrition is indirect, its consistency should incite us all to have a closer look.

The type of economic growth (or decline) that has accompanied the recent era of globalization (increasing disparities) is definitely contrary to that necessary for nutrition improvement. An equitable growth strategy has been shown to be more efficient than compensatory poverty-alleviation programs. Investments in health and in education in ways that reach the malnourished, as well as deliberate policies to improve nutrition through community-based programs do appear to accelerate improvements in nutrition. Nutritionists need to pursue these more acceptable actions to help people everywhere seize the positive opportunities that globalization can provide. However, the global nutrition community must also be active on these other fronts if we are to ensure that globalization does offer more real opportunities for the poor and malnourished.

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Can we in the first decades of the 21st century mobilize an activism in academia and much more broadly, that can tame economic globalization and the inequity it produces, and at same time promote the universalization of rights—including right to adequate food, care and health (Latham and Beaudry 2001).

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