The world’s population, especially in less developed countries, is expected to continue expanding. This growth is occurring together with a demographic transition due to increases in lifespan, and decreases in mortality and fertility. As a result, the number of people aged above 60 years in less developed countries is expected to increase from the current 8% to 20% in 2050, with the group aged above 80 years growing almost five-fold. Read more on page 6
Micronutrient Status, Immune Response and Infectious Disease in Elderly of Less Developed Countries
Adequate nutritional status is essential for efficient immune function, especially for health and disease prevention in the elderly.

Lack of Association Between Helicobacter pylori Infection, Anemia and Growth Impairment in Children
Several studies have shown controversial results about the association between \( H. \text{pylori} \) infection and iron deficiency or anemia in children and young people.

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Why Doesn’t Nutrition Get More Respect?

The title of this guest editorial more or less conveys the topic of several panel discussions at the recent International Congress of Nutrition in Bangkok. In actual fact, some populations already give “nutrition” more attention (and respect) than perhaps it deserves! The average American is almost pathologically obsessed by news reports of the latest (and often contradictory) “dietary health experts, discoveries and recommendations.”

But many leaders within the nutrition community are rightly concerned that global nutrition policy and programs, particularly those aimed at poor, nutritionally deficient populations, receive little attention and support from political leaders and major funding agencies, particularly when compared with the recent explosion of interest and investments in “global health.” This discrepancy should not be surprising, and overcoming it will prove challenging.

Swine flu, SARS and HIV are seen as urgent threats; investing in their control in poorer countries helps to reduce their risk of spread to wealthy countries. In contrast, malnutrition is largely invisible, and poses no risk to wealthier nations.

Present calls to invest more in “nutrition” also miss a subtle distinction. The current interest in “global health” is not actually about “health” at all. Bono, Clinton, Gordon Brown and other public leaders have rallied around specific diseases; particularly diseases for which there are focused interventions: treatment of AIDS, bednets for malaria, DOTS for TB, and polio eradication (as difficult as that may be proving). “Malnutrition” is not a specific entity; it therefore lacks the immediacy and tactile nature of specific (largely infectious) diseases.

Our nomenclature reinforces the problem. The non-emotive term, “malnutrition,” is hard enough to explain; we compound the problem when we speak of issues like “the double burden of malnutrition.” “Double burden” may be a clever, short-hand rallying cry for the nutrition and public health cognoscenti, but just try explaining it to a science writer or a politician.

We also fail to send clear messages, because we needlessly bicker over the meaning of “scientific” data. One exuberant debate at the Micronutrient Forum in Beijing earlier this year pitted the conclusions of two tightly controlled trials of newborn vitamin A dosing in similar populations, both with high baseline infant mortality and serious vitamin A deficiency, against a “meta-analysis” that combined these two trials with ones in which populations were not particularly vitamin A deficient, had considerably lower infant mortality, or failed to administer vitamin A within the first few days of birth. “Context” is usually everything; for this meta-analysis, originally commissioned by WHO, it apparently counted for little. No one would expect penicillin to prevent coronary artery disease; why would one expect vitamin A to be effective in non-deficient populations with relatively low mortality rates; unless of course one were postulating an entirely different mechanism of action?

Context and consistency was well illustrated by another event that took place at the Forum: the presentation of the long awaited results of the well-executed vitamin A maternal mortality trial in Ghana. To many people’s surprise (and disappointment) vitamin A supplementation of pregnant women provided no apparent reduction in their mortality. This stands in striking contrast with an earlier trial in Nepal, where maternal mortality among women randomized to vitamin A (or an equivalent amount of ß-carotene) was only 60 percent that of women in the placebo arm. Some viewed this as contradictory. Yet, had the Ghana trial produced the same outcome as the Nepal trial, there would have been real cause for concern. The baseline vitamin A status of the women in Nepal was extremely poor, and their maternal mortality ratios were very high. In contrast, the vitamin A status of the Ghanaian women was, in comparison, quite good, and their maternal mortality less than half that of the Nepalese women. The results of the two trials could not have been more consistent! A similar, as yet unpublished trial in Bangladesh, yielded the same results as the Ghana trial, and like Ghana, its participants had less than half the risk of death, and considerably better baseline vita-
min A status, than those in Nepal. A “context-free” meta-analysis might conclude that two trials were positive, one was negative, and therefore, on average, there is no potential survival benefit from providing pregnant women with supplemental vitamin A. That, indeed, is what several speakers proposed. A more thoughtful conclusion, of course, is that there may well be a substantial benefit, but only among populations in which women are seriously vitamin A deficient and at high risk of maternal mortality. Not surprisingly, one of the major complaints I received from policy-makers following the Beijing meeting was their confusion about the programmatic implications of these claimed contradictions!

“Diet” of course is “destiny.” The common person (and Minister of Health) is looking to us for guidance about their diet. Nutritionists stand on firm, clear ground when recommending foods that prevent the classic nutritional deficiencies (beri-beri, xerophthalmia, scurvy). But what do we commonly recommend to populations suffering from growing rates of obesity, chronic diseases, and other scourges of plenty: “eat a balanced diet.” But what, precisely, IS a “balanced diet”? I don’t mean “philosophically”; I mean its specific content and preparation. Has human kind ever consumed a “balanced diet”? How would we know? Even Michael Pollan’s admonition, “eat food, preferably plants, in small amounts” is more specific (if far from specific enough).

The US Department of Agriculture revised its famous “food pyramid” several years ago to further emphasize the value of grains and the dangers of meat (fat) consumption. Few people paid any attention to the previous version; even fewer (in this age of fast foods) pay much attention to this revised version. A nifty new, simplified scheme meant to facilitate health-conscious purchasing in the supermarket (“Smart Choice”), would, as one wag put it, award its seal of approval to “sawdust if it was supplemented with vitamins.” That outburst came in response to the bestowal of this “seal of approval” on sweetened breakfast cereals. Criteria for receipt of this seal were developed by a panel of highly regarded nutritionists.

As long as we continue to speak in generalities, conflate our recommendations, or popularize unsubstantiated speculation, the world will never take what we say as seriously as it takes a prescription for penicillin or statins. Perhaps it never will. People think they “understand” food; they know they don’t understand molecular biology.

The new Global Action Plan for Scaling up on Nutrition (“GAP”) initiative is a thoughtful attempt to define a nutrition agenda that the world will understand and support. It has already generated vigorous and helpful debate within the nutrition community; a debate that has begun to clarify the challenges and create much needed consensus and coordination. Its great challenge will be fashioning message(s) that politicians and political leaders can grasp and will find compelling and that put forward strategies that realistically address local capacity and engagement.

On a personal note, after three decades of service on the IVACG/Micronutrient Forum Steering Committee, including nearly two decades as its Chair, it is now time (perhaps long past time!) for me to step down. The Micronutrient Forum (and IVACG before it) provides a collegial, efficient and productive venue for researchers, policy-makers and program leaders to share information and insights. It has also strengthened support for, and attention to, evidence arising from field-based observational data and trials on representative populations; evidence that often ran counter to established orthodoxy. This important evolution has added greater credibility to both our science and to our recommendations.

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Micronutrient Status, Immune Response and Infectious Disease in Elderly of Less Developed Countries

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Introduction

The world’s population, especially in less developed countries, is expected to continue expanding. This growth is occurring together with a demographic transition due to increases in lifespan, and decreases in mortality and fertility. As a result, the number of people aged above 60 years in less developed countries is expected to increase from the current 8% to 20% in 2050, with the group aged above 80 years growing almost five-fold. When using country median age as an indicator of ageing, the 2006 Revision of the UN World Population Prospects shows that the overall world population will age (Figure 1) and that this shift will occur mainly in developing countries. But, even though lifespan has increased, quality of life has not improved for this age group, leading to unhealthy ageing and increased morbidity. As eloquently expressed in the 1995 State of World Health: “For most of the people in the world today, every step in life, from infancy to old age, is taken under the twin shadows of poverty and inequity, and under the double burden of suffering and disease. For many, the prospect of a longer life may seem more like a punishment than a prize.” A primordial objective is not only to increase lifespan but to achieve successful ageing, which is defined as minimizing the time between the onset of illness and death.

The elderly in the less developed world play an important role in society and in their country’s economy. However, they are vulnerable to malnutrition and suffer from infectious diseases. Additionally, many elderly people from less developed countries have experienced an increase in chronic diseases as a consequence of the double burden of malnutrition. The increase of infectious and non-communicable disease within this expanding population has translated into poor quality of life and an increased burden on the healthcare systems of their countries.

Subclinical levels of micronutrients have been associated with impaired immune function in people above 60 years of age, and it has been found that micronutrient supplementation and improved...
nutrition can enhance immune function. It is important, however, that more information is obtained on regional micronutrient status and the benefits a nutrition intervention might have. Such studies on elderly populations in the developing world are limited. Often, data obtained from developed countries is applied to less developed countries, or is extrapolated from younger age groups within the same country. Many aspects of populations in developed countries are not applicable to groups in less developed countries. Also, changes in health, physiology, and immune function during ageing make younger groups an inappropriate model for an older group.

In this review, we will describe age-associated changes in immune response, summarize the impact of micronutrients on immune status in the elderly, assess the current micronutrient status of the elderly in less developed countries and its relation to their immune response, and review current interventions to determine what they teach us for improving the health outcomes of this growing population, as well as the obstacles we need to overcome.

Ageing and immunity

Both innate and acquired immunity weaken with age even in “healthy” elderly people. Age-related changes detrimental to the immune system include thymic involution, poor response to vaccinations, impaired response to evolving pathogens and newly encountered antigens, increased vulnerability to infection, increased autoimmunity, and inflammation.

The most widely studied cells of innate immunity with respect to ageing are macrophages. Some, but not all studies have shown that macrophage chemotaxis, phagocytosis, cytokine production, and bone marrow population are compromised with age. Macrophages are part of the defense barrier in the skin; they detect pathogens and defend the body against bacteria. Because skin is affected with ageing, its efficiency as a protective barrier declines and, along with it, macrophage function is altered. This change leads to increased colonization of bacteria and yeast on the skin and on mucosal surfaces. Wound repair is also affected with ageing, partly due to delayed macrophage infiltration and function. This causes delayed symptom manifestation and diagnosis of infection, which exacerbates disease. Therefore, in general, macrophage ability to fight infection is impaired and there is deregulation of the molecules they produce. For example, production of prostaglandin E2, an inflammatory molecule that has been shown to suppress T cell function in aged individuals as well as contributing to several chronic diseases associated with aging, such as cardiovascular and inflammatory diseases, increases with age.

Many aspects related to changes in other innate immune system cells, such as neutrophils, eosinophils, mast cells, and NK cells, remain undiscovered or controversial. However, it is known that neutrophil phagocytosis and superoxide (O$_2^-$) and hydrogen peroxide (H$_2$O$_2$) production is impaired, and mast cell number seems to decrease in the skin. Also, eosinophil function becomes impaired, leading to increased responses to allergens, which partly explains the exacerbation of asthma with older age. Dendritic cell (DC) function decreases with age and chemotaxis may be compromised but it is not clear whether the number of DCs decreases.

The adaptive immune system, whose main players are T and B cells, is widely modified with ageing. Even though peripheral B cell number and secreted immunoglobulin levels stay constant with age, there is impaired naïve B cell production, less affinity from antibodies to antigen, and more autoantibodies produced. These changes may reduce the response to newly encountered antigens.

It has been established that T cell decline is the main cause of immune senescence. There is a reduced number of naïve T cells and an expansion of memory T cells. This imbalance results, in part, from thymic involution and the expansion of memory T cells as a result of persistent or latent pathogens. The imbalance leads to a decreased response to new antigens, such as new strains of influenza. Additionally, CD4 T helper cell number and function declines, and CD8 cytotoxic effector T lymphocytes (CTLs) have reduced intensity in their response against influenza vaccine and less interferon-gamma (IFNγ) production during viral infections. Influenza is the fifth cause of death in people older than 50 years.
This age group is a target for vaccination campaigns, but influenza virus vaccines have only 30–40% efficacy in the elderly.\textsuperscript{11,13} In addition to age-associated immunological changes, which predispose the elderly to a higher incidence of infectious diseases, a recent report by Gay et al\textsuperscript{21} showed that passage of an avirulent coxsackie B3 virus (COXB3-0), which normally does not cause morbidity and mortality in young mice, through an old host resulted in several mutations in the virus that increased its virulence, transforming it into a morbidity- and mortality-causing virus for the young mice. These results indicate that, in addition to immunological changes, increased viral virulence in the aged host could contribute to their higher susceptibility to infection. Given that Beck et al\textsuperscript{22} have shown that micronutrient deficiencies, such as those of selenium and vitamin E, also increase viral virulence, and there is a high prevalence of nutritional deficiencies in less developed countries and an increasing number of older people in these countries, these findings could have significant public health implications worldwide, and emphasize the need to address nutritional deficiencies in the elderly populations of less developed countries.

**Micronutrient status, ageing and immunity**

Adequate nutritional status is essential for efficient immune function. Investigating this relationship and its relevance to ageing is of great importance for the health of the elderly and for disease prevention.\textsuperscript{8} Many postulate that improvements of nutritional status in elderly populations will enhance their immune system.\textsuperscript{8,20} In turn, this would lead to enhanced nutritional status by preventing the consequences of infectious disease, such as nutrient malabsorption, nutrient and energy store loss, and reduced appetite.\textsuperscript{3} There is a large body of evidence on the potential benefits that micronutrient enhancement can have for the ageing immune system. However, much of this evidence comes from the developed world and has yet to be extended to less developed countries.

There are several comprehensive reviews of micronutrient supplementation studies in the elderly.\textsuperscript{3,23} Single nutrient supplementation studies have shown improvement in the immune response of the elderly. These nutrients include vitamin B\textsubscript{6},\textsuperscript{24,25} vitamin C,\textsuperscript{26,27} vitamin E\textsuperscript{9,28,29} and zinc.\textsuperscript{30,31} Also, there may be a role of vitamin D in age-related deregulation of the immune response in the elderly.\textsuperscript{32,33} However, more studies on this topic are needed. Additionally, there are studies supporting that certain micronutrients, such as antioxidants, be given as a mixture so that they work synergistically, and to prevent an imbalance that may lead to pro-oxidant production.\textsuperscript{34} However, such evidence of supplementation in the elderly remains controversial. A systematic review by Stephen and Avenell\textsuperscript{35} showed that there was no significant effect of micronutrient mixture supplements in the elderly. But, subgroup analysis within that study showed that elderly individuals who were undernourished at baseline and consumed supplements for six months experienced the greatest benefit. A high proportion of elderly people in developed countries take multivitamins, which may bias the results of an intervention trial. Therefore, the lack of effect observed following micronutrient supplementation in developed countries might not be applicable to less developed countries.

A randomized controlled trial in which Girodon et al\textsuperscript{36} supplemented institutionalized elderly subjects with zinc, selenium, and vitamins A, C, and E for two years showed significant improvement in antibody production in response to influenza vaccine in groups receiving single supplements or combinations thereof. Also in this study, a correlation was observed between zinc and selenium supplementation and reduction of respiratory infections. This study suggests that elderly vaccine response can be enhanced through micronutrient supplementation, which would not only prevent
Micronutrients and Immune Response in the Elderly

Long-term daily supplementation of 479 healthy adults (aged 18–67 years) with vitamins and minerals, with or without probiotics, did not show a difference in the incidence of common colds; however, shorter duration of colds, decreased severity of symptoms, and enhanced T cell responses were observed. Furthermore, it has been suggested that probiotics in enhancing response to vaccines in the elderly. Since the ‘indigenous microbiota’ population in the intestinal mucosa changes with age, probiotic supplementation together with micronutrient supplementation may have a positive impact on elderly immunity. In summary, the studies described above, conducted in developed countries, indicate that micronutrient and other dietary interventions could be of benefit to the elderly of less developed countries in providing protection against infection and other immune/inflammation-related diseases, minimizing the number of years in a person’s life during which he or she will suffer from recurring disease (Figure 2), and allowing healthy ageing.

Micronutrient status, immune response and infectious diseases in elderly from less developed countries

The most prevalent and targeted causes of malnutrition worldwide are protein energy malnutrition and vitamin A, iodine, iron, and zinc deficiency. Data on micronutrient status in less developed countries is abundant for vulnerable groups, particularly children and pregnant women, but scarce for the elderly. The reasons for elderly populations’ vulnerability to malnutrition in less developed countries include poor diet, food insecurity, lack of public health measures, and low allocation of government funds to the health care system, resulting in a higher incidence of diseases. In many less developed nations, consumption of foods from animal origin is very low due to inaccessibility and/or religious practices, limiting micronutrient consumption. This scenario also translates into low protein consumption, which has been shown to impair the immune system in the elderly. In addition, many regions have high consumption of phytochemicals, further lowering the absorption of minerals in a group that already has limited access to nutrients. All these factors lead to higher incidence of communicable diseases and, due to the nutrition transition and consumption of food of low nutritional quality, to obesity and chronic disease as well.

In order to target appropriate micronutrient interventions and develop effective public health measures, more detailed nutritional data is needed from less developed nations. Nutritional status, even though generally impaired in poor elderly populations, differs greatly between regions. The recommended micronutrient dosages to be used in supplementation in less developed countries, listed elsewhere, divide individuals into three age groups: 1–3 years, 4–13 years, and > 14 years. The elderly are grouped together with adults, but due to their impaired nutrient absorption and intake, not to mention disease status, they may require different doses for certain nutrients.

Table 1 summarizes studies that have reported micronutrient status in less developed country elderly populations and the relationships between micronutrients, immune response and infection. From this limited data, it is clear that micronutrient deficiencies vary greatly from region to region, even within the same country. Even though
vitamins C and E play an important role in immune function and the prevention of chronic diseases due to their antioxidant properties, very little data has been acquired from elderly populations in less developed countries on these micronutrients. Hamer et al\textsuperscript{5} reported that 92.4\% of elderly Ecuadorians were deficient in vitamin C and that low plasma vitamin C and zinc levels correlated with immune cells’ impaired ability to produce IFN-\(\gamma\). A little more is known about B vitamins, which are important in the development of chronic disease, anemia, and cognition impairment, and are involved in a wide array of cellular functions, including immune response. Vitamin B\(_{12}\) deficiency is common in the elderly both in developed and less developed countries. In the less developed world, however, there is a higher prevalence and it starts earlier in life\textsuperscript{5,47} because of low dietary intake and other environmental factors. Helicobacter pylori infection has been identified as one of the causes of poor vitamin B\(_{12}\) absorption. There is evidence that probiotic supplementation can help displace harmful bacteria and repopulate harmless or beneficial intestinal flora. Parasitic infections are common in less developed countries among both children and the elderly. Hamer et al\textsuperscript{5} found that most elderly Ecuadorians in their study had parasites.\textsuperscript{5} In addition, as shown in Table 1, other B vitamin deficiencies are also prevalent. For example, riboflavin deficiency has been found in several countries in the past few decades.

Iron deficiency anemia (IDA) affects about one quarter of the world’s population.\textsuperscript{48} The causes for this deficiency in the elderly include low iron intake, high levels of dietary phytates and low animal food consumption, as well as atrophic gastritis, intestinal atrophies, and, in some instances, \textit{Helicobacter pylori} infection.\textsuperscript{49} National data on elderly anemia prevalence is missing from many countries. According to Deitchler et al\textsuperscript{50} only three out of 12 countries studied – Indonesia, Laos, and the Philippines – have recorded anemia prevalence in the elderly and found it to be greater than 30\%. Hamer et al\textsuperscript{5} found that 39\% of the elderly Ecuadorians in their study had serum iron below the reference range. Furthermore, they found that iron status correlated with immune cell ability to produce interleukin-2 (IL-2).

Several organizations and governments estimate micronutrient status in specific regions, but direct measurements are scarce. For example, McLean et al\textsuperscript{48} gathered global and regional data from the WHO Vitamin and Mineral Nutrition Information System for 1993–2005 and determined anemia prevalence in different vulnerable groups based either on actual data or estimations. Data on the elderly were unavailable in almost every country, so only global estimations were made. It was determined that 24\%, or 163 million, of elderly populations worldwide were suffering from IDA, with the highest proportion in low-income countries.

Zinc deficiency is prevalent in the elderly of both developed and less developed countries. Hamer et al\textsuperscript{5} reported that close to 50\% of elderly Ecuadorians had low serum zinc level and low serum zinc levels correlated with low IL-2 and INF-\(\gamma\) levels. Interestingly, Meydani et al\textsuperscript{39} reported that 30\% of nursing home residents in USA also had low serum zinc levels,
which were associated with higher incidence of pneumonia. Results from the study by Hamer et al indicated that elderly Ecuadorians had a much higher prevalence of micronutrient deficiencies compared to those living in USA, and that corresponded with their lower immune response compared to their US counterparts. For example, zinc deficiency was found to be two to three times higher (depending on whether the elderly individuals were living independently or nursing home residents) in elderly Ecuadorians compared to those in USA, and their delayed type hypersensitivity response (a measure of cell-mediated immunity) was half that of their US counterparts. Hamer et al also showed that elderly Ecuadorians have a higher incidence of infectious disease than their US counterparts, and that a significant correlation exists between micronutrient deficiency and infection in these elderly people. While several factors, including sanitation, could contribute to the higher incidence of infection in elderly Ecuadorians compared to their US counterparts, these data point to micronutrient deficiencies as an important contributor.

Summary and conclusions

In summary, the elderly population is increasing worldwide and is suffering from the double burden of disease, i.e. both chronic and infectious diseases. As such, they face significantly more health problems compared to other age groups. Many factors contribute to higher susceptibility of infection in the elderly (Figure 3), chief among which are age-related immunological changes. In addition, recent data suggest that the environment of elderly hosts might increase viral virulence, and morbidity and mortality from such causes. The limited data available suggest that the elderly in less developed countries suffer from a high prevalence of several micronutrient deficiencies. Furthermore, these reports indicate that the prevalence and type of micronutrient deficiencies differ by region, and are correlated with low immune response and high incidence of infection. Micronutrients are needed for immune response and their deficiency not only impairs the immune response, but could also increase viral virulence by causing mutations in the virus.

Thus, the combined impact of immunological defects, increased viral virulence in the aged, and the presence of micronutrient deficiencies in the aged not only puts the elderly of less developed countries at high risk of infection, morbidity and mortality from them, but could pose a public health problem for all age groups by contributing to the spread of more virulent viral species. Therefore, there is an urgent need to address the nutritional problems of the elderly in less developed countries so that effective intervention strategies can be devised. Region-specific studies to determine micronutrient status are needed so that cost-effective supplementation strategies can be proposed. For those countries in which specific deficiencies have already been described, studies are needed to demonstrate the efficacy of specific micronutrient supplementation regimes to improve immune response and decrease infectious diseases.

Even though much data remain to be gathered with respect to micronutrient status in the elderly from less developed countries, especially as it pertains to immune response, some initiatives have been taken to improve elderly health and quality of life. In response to the demographic transition and the economic strain of elderly disease, Chile’s government developed a program to distribute a micronutrient mix fortified with vitamins and minerals to low-

![Figure 3: Holistic view of factors that influence the immune system](image-url)
<table>
<thead>
<tr>
<th>Location</th>
<th>Reference</th>
<th>Age (years)</th>
<th>Sample size</th>
<th>Study description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Guatemala</td>
<td>Boisvert et al(^51)</td>
<td>50+</td>
<td>433</td>
<td>Cross-sectional study. Dietary assessment and riboflavin status.</td>
</tr>
<tr>
<td>Bangkok, Thailand</td>
<td>Prayurahong et al(^52)</td>
<td>NA (elderly)</td>
<td>147</td>
<td>Cross-sectional study. Hematological data.</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>Allain et al(^53)</td>
<td>65+</td>
<td>278</td>
<td>Cross-sectional study. Hemoglobin, folate and B(_{12}) levels in rural and urban elderly.</td>
</tr>
<tr>
<td>Chile</td>
<td>Olivares et al(^54)</td>
<td>60+</td>
<td>274</td>
<td>Cross-sectional study. Anthropometric measurements and biochemical measures of iron, copper, folate, vitamins B(_{12}) and A and C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR).</td>
</tr>
<tr>
<td>Chile</td>
<td>Bunout et al(^55)</td>
<td>70+</td>
<td>98</td>
<td>Randomized controlled trial; lasted 18 months. Micronutrient supplement with or without exercise.</td>
</tr>
<tr>
<td>Chile</td>
<td>Hirsch et al(^56)</td>
<td>70+</td>
<td>108</td>
<td>Prospective study. Six months after folic acid fortification started determined effect on folic acid and B(_{12}) status and plasma homocysteine</td>
</tr>
<tr>
<td>Chile</td>
<td>Bunout et al(^57)</td>
<td>70+</td>
<td>60</td>
<td>Randomized controlled trial. Micronutrient (vitamin E, B(_{12}), folate), probiotic and protein supplementation, and placebo.</td>
</tr>
<tr>
<td>Cape Town, South Africa</td>
<td>Charlton et al(^58)</td>
<td>68.9 (SD = 5.7)</td>
<td>148</td>
<td>Cross-sectional study. 24-hr recall and anthropological measurements.</td>
</tr>
<tr>
<td>Beirut, Lebanon</td>
<td>Sibai et al(^59)</td>
<td>65+</td>
<td>200</td>
<td>Cross-sectional study. Questionnaires, anthropometric measurements, hematological and biochemical analyses period.</td>
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<tr>
<td>Cape Town, South Africa</td>
<td>Charlton et al(^60)</td>
<td>72.7 (SD = 8.3)</td>
<td>285</td>
<td>Cross-sectional study. 24-hr recall, plasma micronutrient levels, anthropometric measurements.</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Cheng et al(^61)</td>
<td>65+</td>
<td>2373</td>
<td>Cross-sectional study (Elderly NAHSIT). Plasma retinol and tocopherol measurements.</td>
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<tr>
<td>Taiwan</td>
<td>Wang and Shaw(^62)</td>
<td>65+</td>
<td>2354</td>
<td>Cross-sectional study (Elderly NAHSIT). Plasma iron measurements.</td>
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<tr>
<td>Taiwan</td>
<td>Wang et al(^63)</td>
<td>65+</td>
<td>1911(^$)</td>
<td>Cross-sectional study (Elderly NAHSIT). 24-hr recall and biochemical measurements of magnesium.</td>
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<tr>
<td>Taiwan</td>
<td>Yang et al(^64)</td>
<td>65+</td>
<td>2379</td>
<td>Cross-sectional study (Elderly NAHSIT). Biochemical measurements of thiamin and riboflavin.</td>
</tr>
<tr>
<td>Quito, Ecuador</td>
<td>Sempertegui et al(^6)</td>
<td>74.3 (SD = 6.9)</td>
<td>145</td>
<td>Cross-sectional study. Nutritional assessment through 24-hr recall, DTH, biochemical and anthropometric measurements.</td>
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<tr>
<td>Quito, Ecuador</td>
<td>Hamer et al(^5)</td>
<td>74.4 (SD = 6.4)</td>
<td>352</td>
<td>Cross-sectional study. CRONOS Questionnaires, anthropometric, blood micronutrient and immuno assays.</td>
</tr>
</tbody>
</table>

\(^\$\)For dietary intake; \(^\$\$\)for plasma Mg levels; DTH = delayed type hypersensitivity; RI = respiratory infection; NA = not available;
### Micronutrient Status Findings

<table>
<thead>
<tr>
<th>Micronutrient Status Findings</th>
<th>Immune response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riboflavin deficiency prevalence was 50–76%. Levels correlated with milk intake. Small</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>intervention trial revealed strong correlation between riboflavin status and dietary intake.</td>
<td></td>
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<tr>
<td>15% of subjects had anemia, 21% were folic acid deficient, and 7% were B₁₂ insufficient.</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>Anemia seen in 23% of subjects, 30% had low folate level, and 13% had low serum B₁₂ level</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>Folate was lower in urban subjects and B₁₂ was lower in rural subjects.</td>
<td></td>
</tr>
<tr>
<td>5% men and 4% women were anemic. Abnormal serum retinol was seen in 14% of men and 16% of</td>
<td>10% subjects had inflammation (high ESR and CRP values, and high white blood cell</td>
</tr>
<tr>
<td>women. Folate deficiency was 50% in men and 33% in women. B₁₂ deficiency seen in 51% of</td>
<td>count). They had higher prevalence of anemia (22% men and 32% women).</td>
</tr>
<tr>
<td>men and 31% of women. Almost no iron and copper deficiency.</td>
<td></td>
</tr>
<tr>
<td>Compliance with supplement was 48%. Supplemented, and supplemented + exercise maintained</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>weight, lean mass, bone mineral density, serum cholesterol, and had greater muscle strength.</td>
<td></td>
</tr>
<tr>
<td>Folic acid increased, plasma homocysteine peroid decreased, and B₁₂ stayed the same.</td>
<td>Study did not look at immune response.</td>
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<tr>
<td>Authors recommend elderly B₁₂ supplementation.</td>
<td></td>
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<tr>
<td>Micronutrient status was not reported in this study.</td>
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<tr>
<td>About one third had energy intake &lt; 67% RDA. Low intakes of calcium, vitamin D, zinc, and</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>B₆. Low fruit and vegetable consumption. Over half of women and 18% men were obese.</td>
<td></td>
</tr>
<tr>
<td>Deficiencies in zinc, magnesium, α-tocopherol, and vitamin A, D and B₆ were observed in</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>both institutionalized and free-living elderly. Also, they were anemic and had low albumin</td>
<td></td>
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<tr>
<td>levels.</td>
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<tr>
<td>Micronutrient levels (thiamin, riboflavin, niacin, vitamin B₆, folate, pantothenate,</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>biotin, vitamin C, calcium, iron, magnesium, phosphorus, zinc, copper, and selenium) were</td>
<td></td>
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<tr>
<td>inversely related to added sugar intake. Sugar has a nutrient-diluting effect.</td>
<td></td>
</tr>
<tr>
<td>Low prevalence of plasma retinol or α-tocopherol deficiency.</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>Low prevalence of iron deficiency or iron deficiency anemia in men and women. Some</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>subjects had elevated iron stores.</td>
<td></td>
</tr>
<tr>
<td>Dietary magnesium intake was about 70% of RDA, and 8–9% had low plasma magnesium levels.</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>Magnesium levels and diabetes inversely related.</td>
<td></td>
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<tr>
<td>17% men and 14% women were thiamin deficient. 6.6% men and 4% women were riboflavin</td>
<td>Study did not look at immune response.</td>
</tr>
<tr>
<td>deficient. A large proportion (&gt; 11% for thiamin and &gt; 20% for riboflavin) were marginally</td>
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<tr>
<td>deficient for both vitamins.</td>
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<tr>
<td>50% of subjects had low plasma B₁₂, Zn, and Fe. About 30% had low B₆, and 19% were low in</td>
<td>Low DTH response. In previous 6 months, 54% and 21% had at least one episode of</td>
</tr>
<tr>
<td>folate and vitamin D.</td>
<td>RI or diarrhoea, respectively.</td>
</tr>
<tr>
<td>Deficiencies for vitamins C, D, B₆, zinc and folate.</td>
<td>Plasma vitamin C associated with INFγ production. Zinc associated with INFγ and</td>
</tr>
<tr>
<td></td>
<td>IL-2 production. Micronutrient deficiency, poor immune response and burden of</td>
</tr>
<tr>
<td></td>
<td>RI-like pneumonia and common cold, associated with history of recent infection.</td>
</tr>
</tbody>
</table>
income elderly individuals. It would be interesting to determine whether this program has led to disease prevention and improvement of Chilean low-income elderly nutritional status and quality of life.

In conclusion, there is an urgent need to acquire more data on the nutritional status of the elderly in less developed countries and implementing specific interventions. Generation of this information will improve elderly nutritional status in a cost-effective manner, which in turn could result in the reduction of infectious and chronic diseases, improve health status and quality of life in this age group, and achieve significant savings to health care resources in these countries. Furthermore, improving the nutritional status of the elderly in less developed countries could reduce the global burden of infectious disease.

Acknowledgement

The author’s work was supported by USDA contract number 58 1950-7-707, National Institute of Aging grant numbers R01AG 009140, and R01-AG13975, Office of Dietary Supplement, and a Stanley N Gershoff Scholarship.

References


No Association Between *Helicobacter pylori* Infection, Anemia and Growth Impairment in Children

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Introduction

*Helicobacter pylori* infection is the major etiologic factor in the development of chronic gastritis and peptic ulcer disease.¹ It is the most common chronic bacterial infection in humans and its prevalence tends to be higher in developing countries than in developed ones.² Epidemiological studies conducted in Argentina showed a 40% infection prevalence in symptomatic children³ and 15.7% prevalence in the asymptomatic population⁴ – results similar to those reported in developed countries.⁵ On the other hand, it is well known that micronutrient deficiencies affect billions of people in developing countries and iron deficiency remains one of the most severe and important nutritional problems in the world today.⁶ According to the 2007 National Nutritional and Health Survey by the Argentine Ministry of Health, the prevalence of anemia evaluated in infants aged 6–24 months and children aged 2–5 years was 34.9% and 10.6%, respectively.⁷

Several epidemiological studies and some intervention studies have shown controversial results about the association between *H. pylori* infection and iron deficiency (ID) or iron deficiency anemia (IDA) in children and youth.⁸⁹ The Maastricht III Consensus Report on the management of *H. pylori* infection¹⁰ recommended that *H. pylori* infection should be sought for and...
treated in children and adolescents with refractory IDA. Nevertheless, the American College of Gastroenterology Guidelines\textsuperscript{11} established that further properly designed trials would be needed to assess whether \textit{H. pylori} eradication offers benefit to patients with unexplained IDA.

Various studies have related \textit{H. pylori} infection to growth impairment in children and youth\textsuperscript{12-14}. One such study hypothesizes that this infection is the initiator of a vicious cycle of events ultimately resulting in malnutrition and growth impairment in children in particular from developing countries\textsuperscript{14}. Argentina, like other countries in Latin America, today faces an epidemiological nutrition transition; on one hand, obesity is increasing dramatically and, on the other, hidden hunger and infection continue to be public health concerns\textsuperscript{7, 15}. Hence, it is important to ascertain whether \textit{H. pylori} infection is associated with anemia and growth impairment in children.

An epidemiological questionnaire was administered to the parents or guardians of the participant children, which focused on ethnicity, socio-demographic factors, mothers and head of household’s educational level, and household water and sanitation facilities. Unsatisfied basic needs (UBN) were defined according to the guidelines of the Argentine Bureau of Statistics and Census (\textit{Instituto Nacional de Estadísticas y Censos})\textsuperscript{16}.

Children were instructed to fast for at least six hours before the \textsuperscript{13}C-Urea Breath Test (\textsuperscript{13}C-UBT) was performed. Two samples of exhaled air were taken prior to the ingestion of the labeled solution to determine basal \textsuperscript{13}C/\textsuperscript{12}C ratios. Then, 150 mL of milk containing 50 mg of \textsuperscript{13}C-urea (Cambridge Isotope Laboratories Inc., Massachusetts, USA) were taken by each patient. Breath samples were collected in hermetically sealed containers (Labco Ltd, Buckinghamshire, UK) 30 and 45 minutes after the ingestion of the labeled solution. Each sample of exhaled air was measured in a mass spectrometer coupled to a gas chromatographer (FinniganMAT GmbH, ThermoQuest Corp., Bremen, Germany). A change of $>3.5\%$ in the delta over baseline (DOB) value was considered positive\textsuperscript{17}.

Venous blood samples were obtained during the morning to assess iron status, which was evaluated by determination of hemoglobin, serum ferritin (SF), and serum transferrin receptor (sTfR) concentrations. Hemoglobin was measured by an electronic counter through the cyanmethemoglobin method. Serum ferritin was determined by an immuno-radiometric assay (Diagnostic Systems Laboratories, Texas, USA) and sTfR by means of an enzyme immunoassay (TF-94 Ramco Laboratories, Texas, USA). Serum samples were kept at -70 °C until assay. Anemia was defined with hemoglobin values $<115\ g/L$ for children under 12 years, and $<120\ g/L$ for children over that age. SF cut off was $12\ \mu g/L$ for children below 5 years and $15\ \mu g/L$ for children over 5 years. Serum sTfR concentrations were measured as an additional marker of functional iron deficiency, with a normal range of 2.9–8.5 mg/L. ID was defined when SF concentration was lower than the cut off value and IDA when both ID and anemia were present\textsuperscript{18}.

Height was recorded using a stadiometer (Stanley, Morangis, France) and weight was measured by a portable mechanical scale (CAM, Buenos Aires, Argentina). Height and weight were expressed (as $z$-scores) relative to the CDC-2000 age and sex appropriate standards. Underweight and stunting were defined when weight-for-age (WAZ) and height-for-age (HAZ)
z-scores were below minus 2 standard deviations from the median of the reference population. Overweight and obesity were defined according to the body mass index (BMI) centiles > 85 and > 95, respectively.19 Percentiles and z-scores were calculated using EpilInfo, version 3.2 software (Atlanta, Georgia, USA).

The Fisher Exact test and Chi squared were used to analyze dependency between *H. pylori* positivity and other categorical variables. Student’s t test was used when it was proven that variances were homogeneous; if not, the non-parametric Mann-Whitney test was applied. A binary logistic regression was performed to estimate the impact of *H. pylori* status alone and adjusted for confounders as predictive variables for anemia, ID, stunting, underweight, overweight and obesity. Statistical analyses were performed using Epi Info 3.2 (Atlanta, Georgia, USA) and SPSS 11.5 software (Chicago, Illinois, USA).

**Results**

A total of 96 children (24.3%) with a mean age of 9.9 years, were *H. pylori* positive. No significant differences were found between age (P = 0.38) and sex (P = 0.56) and *H. pylori* positivity. *H. pylori* infection was associated to low socioeconomic status, poor sanitary conditions, a high number of siblings and family members, ethnicity, and low educational level of the parents. These results are consistent with epidemiological data previously described by our group in the same population3 and others.20 No significant differences were found for any of the biochemical markers evaluated for iron status between *H. pylori* positive and neg-

| Table 1: Iron biochemical markers in *H. pylori* positive and negative patients |
|----------------|----------------|----------------|-----------|
|                | *H. pylori (+)* | *H. pylori (-)* | P-value   |
| Hemoglobin (g/L) | 126 ± 11       | 127 ± 11       | 0.42      |
| Serum ferritin (µg/L) | 30.9 (16.3–58.6)* | 35.3 (17.8–70.1)* | 0.10      |
| Soluble transferrin receptor (mg/L) | 4.2 ± 1.6 | 4.4 ± 1.6 | 0.38      |

*Geometric mean (± 1 SD)

| Table 2: Effect of *H. pylori* infection on the presence of anemia, iron deficiency, and anthropometric indicators |
|----------------|----------------|----------------|-----------|
|                | OR crude (95% CI) | P | OR Adjusted (95% CI) | P |
| Anemia       | 1.54 (0.73–3.24) | 0.26 | 1.11 (0.49–2.50)*a | 0.81 |
| Iron deficiency | 1.35 (0.67–2.70) | 0.39 | 1.45 (0.69–3.04)*b | 0.32 |
| Stunting     | 1.35 (0.51–3.59) | 0.55 | 1.25 (0.46–3.39)*c | 0.65 |
| Underweight  | 1.50 (0.63–3.60) | 0.36 | 1.28 (0.47–3.46)*d | 0.63 |
| Overweight and obesity | 1.57 (0.46–5.33) | 0.47 | 1.75 (0.5–6.13)*e | 0.38 |

*a Adjusted for source of water and type of flooring
*b Adjusted for type of toilet, mother’s educational level, ethnic group and overcrowded
*c Adjusted for age
*d Adjusted for anemia and head of household’s educational level
*e Adjusted for overcrowding and UBN
ative patients (Table 1). Prevalence of anemia was 12.0% (95% CI, 7.2–22.6%) for the *H. pylori* positive group and 8.9% (95% CI, 6.0–13.6%) for the *H. pylori* negative group. ID was found in 14.3% (95% CI, 7.8–23.2%) and 11.0% (95% CI, 7.6–15.2%) of the *H. pylori* positive and negative patients, respectively. A low rate of IDA was observed in the studied population, with a prevalence of 2.4% (95% CI, 1.1–4.8%).

A binary logistic regression was performed to estimate the impact of *H. pylori* status alone and adjusted for confounders as a predictive variable for anemia, ID, stunting, underweight, overweight and obesity. The results showed that there was no association between *H. pylori* infection, iron status and anthropometric indicators (Table 2).

The prevalence of stunting found was 5.0% and 6.2% for *H. pylori* negative and positive patients. Underweight was determined in 5.7% and 8.3% of the *H. pylori* negative and positive patients. In addition, obesity and overweight was found in 15.3% and 20.0% of the infected and non-infected patients. In the present study, no significant differences were found between anthropometric indicators and *H. pylori* status (Figure 1).

Discussion

Although the relationship between *H. pylori* infection and ID or IDA has been studied by several groups over the last two decades, a uniform and clear conclusion has still not been reached. A number of cross-sectional studies performed in children and youth described an association between *H. pylori* infection and IDA, although other reports demonstrated a lack of association between *H. pylori* either with IDA or with anemia. One variable that should be taken into account for the comparison of the results of different studies is the methodology applied for the diagnosis of *H. pylori* infection, as it was shown by DiGirolamo et al. According to these authors, who evaluated the association between *H. pylori* infection and IDA in children from Alaska, IDA was associated with positive *H. pylori* serology results, whereas no association was established with positive 13C-UBT or fecal antigen test values. These findings contrast with those found in a cross-sectional study conducted in the same population, in which positive 13C-UBT results were associated with IDA.

Relatively few intervention studies have sought to establish a cause-and-effect relationship between *H. pylori*, ID and anemia. One of the largest and most recent randomized controlled trials performed in 200 Bangladeshi children concluded that *H. pylori* infection is neither a cause of IDA/ID nor a reason for the treatment failure of iron supplementation in young children. Moreover, a study which evaluated iron absorption by the use of stable isotopes supported these findings: iron absorption did not differ between *H. pylori* infected children with anemia and anemic controls, even after *H. pylori* eradication.

Our study revealed that *H. pylori* infection was not associated with ID or anemia although lower serum ferritin levels were observed in *H. pylori* positive patients. Our results, along with others from a coordinated series of cross-sectional studies in Latin American countries, reported the lack of association between *H. pylori* and anemia, which argues against the causative role of this bacterium in the development of anemia in Latin America.

Some cross-sectional and prospective studies have shown an association between growth delay and *H. pylori* infection in children, although other studies suggested that *H. pylori* infection seemed to affect growth as a result

![Figure 1: Effect of Helicobacter pylori infection on anthropometric indicators](image-url)

HAZ: height-for-age; WAZ: weight-for-age; BMI: body mass index
of a concomitant presence of IDA or low socioeconomic status.\textsuperscript{12,36} A cohort study performed in 347 infants showed a significant and nontransient effect of \textit{H. pylori} infection on height and weight.\textsuperscript{37} In contrast, another study suggested that \textit{H. pylori} colonization in early infancy would predispose the development of malnutrition and growth faltering, although the effect did not persist into later childhood.\textsuperscript{13}

Our results showed that \textit{H. pylori} infected children tend to have lower WAZ, HAZ, BMI, although these differences were not statistically significant. Similarly, cross-sectional studies by Leandro Liberato et al\textsuperscript{38} and Chimonas et al\textsuperscript{39} also reported a lack of association between \textit{H. pylori} infection and growth – results that were corroborated after an interventional study.\textsuperscript{39} Given the important role in socioeconomic status on anthropometric development, it should be taken into account its evaluation to ascertain the reported discrepancies.

In conclusion, the relationship between \textit{H. pylori} infection, anemia and growth impairment is still controversial. Additional prospective controlled studies need to be conducted to clarify this important issue.

**Acknowledgement**
This work was supported by the ARCAL LIV-6042 and ARCAL LIV-6054 Projects of the International Atomic Energy Agency (IAEA), Vienna, Austria; the PICT 14243 Project of the National Agency of Scientific and Technological Research, Argentina; and the UBACyT B007 Project of the University of Buenos Aires, Buenos Aires, Argentina.

**References**


Introduction

Vitamin A deficiency is a serious public health problem in less developed areas of the world where the population earns a low income and consumes diets low in vitamin A. Chronic intake of foods low in vitamin A and β-carotene forming an unbalanced diet with little variety, which leads to micronutrient deficiencies, is common in many populations. The most vulnerable groups affected are pregnant or lactating women and preschool children, with an estimated 250 million at risk of developing vitamin A deficiency disorders (VADD).

Deficiency in these groups occurs largely due to increases in physiological requirements, together with a low dietary intake of vitamin A.2 Provitamin A carotenoids, particularly β-carotene, are a major source of vitamin A for the world’s population. Vitamin A from animal sources are usually expensive and rarely relied upon to meet daily requirements in developing countries. It has been noted that Asia and Africa, where the most serious problems of VADD occur, place the greatest reliance on provitamin A sources with approximately 80% of dietary vitamin A derived from carotene-rich plants.3

However, the average intake of pre-formed retinol is low even in the UK, with average intakes of 673 µg (median 363 µg) for men and 472 µg (median 277 µg) for women.4 This intake includes the consumption of dietary supplements, mostly comprising of multivitamins, cod and halibut liver oil, which are consumed by 34% of women and 18% of men.4 The percentage of men and women with intakes of pre-formed retinol below the recommended nutrient intake (RNI) or the lower recommended nutrient intake (LRNI) are 81% and 43%, respectively (Figure 1), indicating that, for a majority of the UK population, vitamin A requirements are not met by dietary intake of pre-formed retinol.

In calculating the retinol equivalence (RE) of total vitamin A from food sources (provitamin A sources plus preformed vitamin A), several assumptions are made for the degree of bioavailability and bioconversion (Figure 2). The bioavailability of retinol derived from foods of animal origin is assumed to be 100%, hence, 1 RE is equal to 1 µg of all-trans retinol. Before 1995, it was assumed that 6 µg of dietary β-carotene would provide 1 µg of RE and that 12 µg of all other provitamin carotenoids must be ingested to yield 1 µg RE. Since then, however, several studies have suggested that dietary β-carotene may not be effective in improving vitamin A status. de Pee et al called for a re-examination of the conversion factors for fruits and vegetables when daily portions of green leafy veg-

Can the β-Carotene Low Responder Phenotype be Caused by Genetic Polymorphisms in the β-Carotene 15,15’-Monoxygenase Gene?

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Magazine Issue 3/2009

Genetic Variation in \( \beta \)-Carotene Cleavage

Tables were found not to be effective in improving vitamin A status.\(^5\) Since it was reported that 12 µg of \( \beta \)-carotene from fruits provided 1 µg RE and 26 µg of \( \beta \)-carotene from green leafy vegetables provided 1 µg RE,\(^6\) the International Vitamin A Consultative Group (IVACG) as well as the Institute of Medicine (IOM) adopted new conversion factors for \( \beta \)-carotene in fruits and vegetables, with 12 µg \( \beta \)-carotene and 24 µg other provitamin A carotenoids providing 1 µg retinol activity equivalent (RAE) in a mixed diet. This raises the question of whether the current recommendation of 2–4 mg \( \beta \)-carotene per day in industrialized countries could close the gap between the low intake of preformed vitamin A and the recommended intake (Figure 3).

**The low responder phenotype**

The amount of newly absorbed \( \beta \)-carotene and converted retinol present in the blood after supplementation with \( \beta \)-carotene can be measured in the lipoprotein-rich chylomicron fraction and is highly variable between healthy individuals.\(^7\)–\(^9\) In a number of studies, poor absorbers of \( \beta \)-carotene, shown to have very little \( \beta \)-carotene in the blood after supplementation, have been classified as low responders.\(^8\)–\(^10\) However, in these same studies, poor absorbers of \( \beta \)-carotene also have a low retinol palmitate/\( \beta \)-carotene ratio, which is a measure of conversion efficiency, indicating that not only are they poor absorbers but also poor converters of \( \beta \)-carotene. Up to 45% of volunteers have been classified as poor converters.\(^8\)–\(^10\),\(^11\) These individuals have a capacity to form only 9% vitamin A from \( \beta \)-carotene compared to those who are classified as normal converters.\(^11\) Genetic variability in \( \beta \)-carotene metabolism may provide an explanation for the molecular basis of the poor converter phenotype within the population. The enzyme responsible for \( \beta \)-carotene conversion into retinol is \( \beta \)-carotene 15,15'-monooxygenase (BCMO1), and approximately 95% of retinoids arising from \( \beta \)-carotene are produced by this pathway *in vivo*.\(^12\) BCMO1 is a soluble cytosolic enzyme that shows the highest activity in intestinal mucosa, specifically in jejunal enterocytes.\(^13\) Elevated levels of BCMO1 mRNA are also found in the liver, lung, and kidney, and lower levels in the brain, prostate, ovary, colon, and skeletal muscle, which suggests the impor-

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**Figure 1:** Proportion of females in the UK with preformed vitamin A intakes below the recommended nutrient intake (600 µg) and lower recommended nutrient intake (250 µg).

Data extracted from Henderson et al\(^4\)

**Figure 2:** Bioefficacy of provitamin A conversion with new conversion factors.

Adapted from West et al\(^{20}\)

<table>
<thead>
<tr>
<th>Consumed</th>
<th>Absorbed</th>
<th>Bioconverted</th>
</tr>
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<tbody>
<tr>
<td>Dietary supplemental vitamin A (1 µg)</td>
<td>Retinol</td>
<td></td>
</tr>
<tr>
<td>Supplemental ( \beta )-carotene in oil (2 µg)</td>
<td>( \beta )-Carotene</td>
<td>Retinol (1 µg)</td>
</tr>
<tr>
<td>Dietary ( \beta )-carotene (12 µg)</td>
<td></td>
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<tr>
<td>Dietary ( \alpha )-carotene or ( \beta )-cryptoxanthin (24 µg)</td>
<td>( \alpha )-Carotene or ( \beta )-cryptoxanthin</td>
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Genetic variations in the β-carotene cleavage enzyme

It was recently shown that the T170M missense mutation in the β-carotene 15,15'-monooxygenase gene (BCMO1) causes a dramatic decrease in the enzyme activity in vitro, and is associated with hypercarotenemia and hypovitaminosis A in a heterozygote carrier. However, given its very low frequency, this mutation cannot explain the high frequency of the low convertor phenotype observed in humans. Our group screened the total open reading frame of the BCMO1 coding region that leads to the identification of two common non-synonymous single nucleotide polymorphisms (R267S; rs12934922 and A379V; rs7501331) with variant allele frequencies of 42% and 24%, respectively. These frequencies are close to those observed for the low responder phenotype.

More important, however, was the observation that carriers of both the 379V and 267S+379V variant alleles had a reduced ability to convert β-carotene by 32% and 69%, respectively, and consequently higher fasting β-carotene concentrations (Figure 4). Further evidence of the interaction of genetic variability with the low responder phenotype comes from the analysis of a recent genome-wide association study that indicated a strong link between fasting β-carotene concentrations and polymorphisms in the vicinity of the BCMO1 gene. However, it is yet unclear whether the identified SNPs (Single Nucleotide Polymorphisms) in the vicinity of BCMO1 influence the ability to cleave β-carotene. Although the authors have indicated that their identified genetic vari-
ants had no significant effect on plasma retinol concentrations, this is not an indication of whether these SNPs will influence β-carotene conversion efficiency since plasma retinol concentrations are maintained even if liver retinol concentrations are low. More research will be needed to identify the mechanistic role of these genetic variants on vitamin A metabolism.

**Variations in polymorphism frequencies between ethnic groups**

Interestingly, the variant allele frequencies of the functional polymorphisms identified in our study, R267S and A379V, were similar in Americans with European ancestry but lower in Han Chinese and Japanese populations (Figure 5). More importantly, the 379V variant allele was not found in the Yoruba Nigerian population. Although the current HapMap database indicates that large differences in frequencies between ethnic groups occurs for the 379V and 267S+379V variant alleles, we have, to date, no data on population groups for which vitamin A deficiency is a recognized public health problem.

**Conclusions**

It is clear that more research is needed to shed some light on this important nutrient-gene interaction in those populations for which vitamin A deficiency is a serious public health problem. Genetic variability should be taken into account in future recommendations for vitamin A supplementation. It is possible that populations with a high frequency of the 379V variant allele may benefit from supplementation with preformed vitamin A rather than increased intake of plant provitamin A sources to combat vitamin A deficiency. However, more research is needed before such recommendations can be made.

**References**

Introduction

Orange sweet potato (OSP) rich in provitamin A (PVA) is part of an international biofortification effort by HarvestPlus, the International Potato Center (CIP), and others to reduce vitamin A and other micronutrient deficiencies through staple food crops with enhanced micronutrient content. Sweet potato constitutes the 8th most important food crop in the world with > 107 million MT produced per annum. It has been suggested by CIP that production (and by extension consumption) may be underestimated due to the challenges of tracking multiple annual harvests on small non-contiguous plots with little yield destined for international markets. Because of its nutrient content and many excellent agronomical characteristics such as high productivity, drought resistance and ability to grow in marginal soils, the importance of OSP as a food-security staple should continue to increase.

HarvestPlus’s goal is to breed sufficient levels of micronutrients into crops to have a measurable impact on human nutritional and health status without sacrificing their agronomic qualities, such as yield and disease resistance. Development of biofortified crops includes research on post harvest nutrient retention, dietary intake and consumer acceptability, bioavailability (or bioconversion to retinol in the case of PVA-rich foods), efficacy, large scale dissemination of the biofortified crop, and effectiveness in specific target country contexts. For OSP, the potential for success is clear, as recently demonstrated in Mozambique where regular OSP consumption had a significant positive effect on serum retinol concentrations among children taking part in a 2 year integrated agriculture-nutrition intervention versus controls (P < 0.01).

The purpose of this review is to update information on the impact of common cooking methods on PVA concentration in OSP as reflected by the percent...
Results

Studies were balanced between those that attempt to emulate traditional cooking techniques with those that use standardized food technology laboratory methods. No true community studies of roots processed by target populations were available and most studies used different protocols even within each processing method.

Seven different processing techniques were explored for retention of PVA carotenoids (boiling, steaming, frying, roasting, microwaving, baking, and drying). Table 1 displays a listing of each by author, percent retention (average/range), whether \(\text{trans-}\beta\)-carotene (BC) or all-carotenoid (AC) retention was measured, the duration of processing (min/hrs), the type of retention calculation used (true, apparent, dry weight basis)\(^{11}\), whether more than one cultivar was included in the analysis and finally, if and why a study was excluded from analysis. Average retention values by processing technique are unweighted arithmetic means of all BC and AC data points from studies included in the review.

Boiling was the most commonly studied cooking process (11 of 20 retention publications). It is also among the most common and affordable sweet potato cooking techniques in developing countries, as it does not require additional ingredients.\(^{12}\) Boiling was found to have one of the highest retentions on average (84\%, Range: 50–130\%) of any processing technique (Figure 1).\(^{13-20}\) Among three studies that recorded the isomerisation effect, the average cis-isomer content following boiling was 9\% of BC\(^{14,15}\) and 12\% of \(\text{trans-}\beta\)-carotene\(^{16}\) (average 11\%). This compares to an average of 1.5\% in fresh roots (Figure 2).\(^{14-16}\)
Table 1: Carotenoid retention in orange sweet potato by processing technique

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<th>Processing Technique</th>
<th>Time</th>
<th>Ave (%)</th>
<th>Min (%)</th>
<th>Max (%)</th>
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* DWB: Dry Weight Basis
**This average retention for frying excludes Wu^20 which, unlike other authors, fried pre-boiled mashed sweet potato
***This average retention for frying excludes Wu^20 which, unlike other authors, steamed sweet potato prior to drying
NA: not available; BC: trans-β-carotene; AC: all-carotenoid
Notwithstanding the variability of boiling methodologies used, there was a moderate inverse correlation \((r = 0.50)\) between cooking time and carotenoid retention and a significant coefficient of determination \((R^2 = 0.25; P < 0.0001; N = 38)\). This association is best exemplified by Wu et al\(^{20}\) in which five portions of sweet potato were boiled one by one for 10, 20, 30, 40 and 50 min. A corresponding drop in retention was found at each time period demonstrating a strong and significant negative correlation despite a small sample size \((R^2 = 0.97; P < 0.001; N = 5)\).

It has been assumed that boiling whole sweet potato reduces BC loss compared to cut and/or peeled fractions due to surface area reduction and the peel’s protective effect;\(^{5}\) however, data in this review were insufficient to validate this assumption. Past research has suggested that retention may be mediated by cultivar BC content (and intracellular location)\(^{21}\) and/or cultivar dry matter content of the raw root.\(^{22}\) However, neither relationship had a strong correlation, \((R^2 = 0.06; P = 0.12\) and \(R^2 = 0.0014; P < 0.0001)\) respectively.\(^{14,15}\)

The effect of full versus partial immersion of roots in water and the use of a lid were addressed in one study.\(^{16}\) Half-immersed sweet potato boiled with lid on for 20 min had 9% less retention than those boiled fully immersed in water over the same time. Steam has greater heat energy transfer than boiling water which may have played a part in this result. Although sweet potatoes cooked fully immersed in capped pots were boiled for 10 min longer than a sample with the lid off, both samples had comparable retention levels, indicating a closed cooking vessel may improve retention slightly.

Steaming is also a very popular way of preparing sweet potato in some countries.\(^{12}\) Average retention was 77% (Range: 48–95%) over three studies\(^{14,19,20}\) and cis-isomers were recorded at 6.4% of BC after 30 min of steaming in one publication\(^{14}\). In one study with peeled and cubed sweet potato, the impact of steaming time on retention was comparable to boiling until 30 min at which point the contents of the steamed cubed roots had 17% less BC and continued to drop thereafter (Figure 3).\(^{20}\)

As discussed previously, in comparison with boiling the higher heat energy of steam may be a factor in reducing retention. On the other hand, in two studies, whole steamed roots wrapped in banana leaves, which may have dampened heat transfer to the root parenchyma, had retention levels roughly comparable to boiled samples despite having been steamed for 10 and 20 min longer.\(^{14,19}\) Regarding cultivar selection, the Kakamega varieties (e.g., SPK004/1 and 6) appear to be superior to their parent variety by as much as 20% during boiling and steaming.\(^{14,19}\)

Frying was found to be a relatively non-destructive process for BC content over the short times needed to fully cook OSP, with an average of 79% retention (Range: 67–95%).\(^{14,18,20,23}\) In two studies cis-isomers were on average 7% of BC.\(^{14,23}\) Although BC retention did not decrease with short frying times of cubed samples (1 vs. 3 min), cis-trans isomerisation did increase significantly (from 2.4 to 15% of BC) \((P < 0.05)\).\(^{23}\) According to the authors, the preparation method for frying (cubes vs. shreds) resulted in a non-significant difference in retention, with shreds retaining 14% more BC than cubes \((P > 0.05)\). This result may be due to greater cell-wall destruction enabling improved extraction of carotenoids.\(^{24}\) A similar phenomenon may have occurred in Wu’s study\(^{20}\) in which pre-cooked (boiled mashed) sweet potato fried for 1 min was found to increase in BC content by 6%.\(^{20}\) Only when sweet potato was fried for 12 min were lower retention results found (68%).\(^{18}\)

Roasting whole sweet potato on a grill was found to be less damaging to BC contents than baking in an oven with 74% (Range: 40–110%)\(^{15,24}\) and 69% retention, respectively. Duration of roasting and fresh root BC content had a non-significant inverse correlation and no correlation with BC retention \((R^2 = 0.39; P = 0.53\) and \(R^2 = 0.004; P = 0.33)\), respectively.\(^{15}\) Isomerization was highest using these cooking techniques, with 12 and 30% of BC found in cis form, respectively. These levels were mildly correlated with cooking time \((R^2 = 0.08; P < 0.001)\).\(^{15,24}\)

![Figure 3: β-Carotene retention (%) during boiling and steaming of sweet potato](image-url)
Microwaving is associated with lower average BC retention values among the conventional cooking techniques examined (67%; Range: 34–92%).20,24 The proportion of cis-isomers was also high in sweet potato cooked with this technique (17% of BC).24 Length of cooking explained a large proportion of the variance in retention ($R^2 = 0.76$; $P < 0.05$).20,24 The microwave power (watts) used in each of the studies also affected retention. Energy-per-unit-time used in Chandler & Schwartz24 was 10-times as high as in Wu20 but the sweet potato received 1/10 the energy-per-unit-weight. Nevertheless, despite a 3-min shorter duration of microwave heating, Chandler’s & Schwartz’s study24 still resulted in 15% lower retention. This would suggest that high power microwave heating is more damaging to BC levels. The molecular mechanism for this occurrence was not elucidated in the publications.

Drying is an important technique for ensuring access to PVA foods during times of scarcity and is a necessary procedure for sweet potato flour production. Retention of BC associated with direct sun drying ranged from 54 to 92% with an average of 59%.14,19,25,26 Among all drying processes cis-isomerization was minimal at approximately 6% of BC.14,15,25 Humidity and drying time played an important role in producing a wide range of retention results. In Bechoff et al26, for example, 15 hours of direct sun in “dry” weather resulted in 92% AC retention and “wet/rainy” conditions (46 hours) resulted in just 54% retention. In the study there was a significant correlation between losses and drying time ($R = 0.727$; $P < 0.01$). Similarly, hot dry conditions (30–52 °C) in Bengtsson et al14 over 6–10 hours yielded a BC retention of 91.1%. Good weather does not always ensure very high retention, however. A recent study by Bechoff et al25 found that over 8 hours in warm (29 °C), dry (39% moisture) and windy weather conditions BC retention was lower (66%).

Shade drying retained higher levels of the nutrient than other drying techniques (91% average retention).15,26 Under “dry” conditions, average AC retention was 97% and in some cases similar to fresh sample levels (-1%)26. Despite the benefits of shade drying it was suggested that a greater likelihood of fermentation was possible than with sun drying.26

Four studies reported on a variety of solar dryers used to process OSP in both wet and dry weather conditions. Retention averaged 82% with a range of between a 56 and 106%.14,25,26,27 Hot and dry conditions resulted in retentions above 90%,14,25,26 with drying occurring 2.6-times as quickly as in “wet/rainy” conditions using tunnel or tent dryers.25 Dryer types (tunnel vs. tent) in Bechoff et al26 did not have different retentions nor was solar drying significantly different than sun drying.

One of the benefits of solar dryers is the capability of increased load density over sun/shade drying. In Mdziniso et al27, the highest BC retention levels in a solar dryer (106%) were found using a wide (5 mm) slice and thick load (430 g/m²) and the lowest retention levels (73%) were found with narrow (3 mm) slice and thin load (715 g/m²). Machine crimping of slices was effective at reducing AC losses in the sun (but not solar dryer) versus flat chips (P < 0.05).25 This was understood to be due to maintenance of better structural integrity with 20% more surface area in crimped than flat slices following drying.

Four studies were included on the effect of oven drying.14,20,25,28 One was not used in calculations due to a pre-baking steaming step.20 Oven dried sweet potato retained on average 87% BC content (Range 79–96%). Bengtsson et al14 found that sun-drying (84%) was not statistically different than solar (91%) or oven drying (88%) at 57 °C in regards to BC retention (P > 0.05). Although in Bechoff et al25, forced-air drying at 24–45 °C
appeared to have better retention (88%) than solar (77%), this difference was not significant (P > 0.05). Nascimento et al.\(^2\) used a higher drying temperature (70 °C) as a means of inactivating oxidative enzymes. The high retention result (96%) indicates that this technique may be effective.

Even while retention in some cases was not significantly improved in oven drying over other drying methods, this process did result in quicker drying of high density loads. In Bechoff et al.\(^3\), for example, the forced air dryer took 2 hours to dry 8 kg/m\(^2\) while the solar dryer technique, even under favourable conditions, took 8 hours to dry at 3.5 kg/m\(^2\) packing density.

Conclusions

OSP contain high levels of BC, with root contents ranging from 1,800 µg to 16,000 µg/100 g\(^2\) fresh weight to as much as 31,000 µg/100 g dry weight in new Kakamega variants.\(^4\) The majority of BC in sweet potato is in the form of \(\text{trans}-\beta\)-carotene which exhibits the highest PVA activity among carotenoids.\(^5\)

Even after traditional and modern cooking methods, OSP continues to be an excellent source of PVA carotenoids. Limitations of this study include lack of pooled statistical analysis. However, the most common preparation methods, boiling and steaming, both yielded retention levels in excess of 75%. This surpasses the conservative assumption of 50% made by nutritionists and plant breeders when initial BC target levels were established for HarvestPlus OSP cultivars. Using this estimate, daily consumption of 100 g of OSP retaining 50% of original BC contents and observing a 12:1 bioconversion rate will provide a child 4–6 years of age with approximately 50% of the estimated average requirement for this vitamin (~126.5 µg RE).

Exception in a few cases, such as baking and microwaving, \(\text{cis}\)-isomer levels were minimal. Frying, which is often thought to be more damaging in regards to BC retention\(^6\), also yielded retention above 75%. Current estimates indicate that a significant proportion of BC is retained through baking and roasting of OSP (69 and 74%, respectively). However, more information is needed to confirm this statement. As demonstrated for the methods reviewed above, results in the field will depend primarily on processing duration, average temperature (heat energy transfer) used during cooking, integrity of the root (surface area of root pulp exposed) and cultivar selected.

Numerous drying techniques in both dry and wet weather also yielded PVA retention results above 50%. Depending on weather conditions, density of the load and innovations such as crimped slices and higher drying temperatures, much higher retentions can be achieved. More data is needed on shade drying, roasting, baking and the result of \(\text{cis}\)-isomerization during various processes to ensure estimates are correct. Future studies should use true retention and a standardized (HPLC) carotenoid measurement protocol, such as that suggested by HarvestPlus\(^7\), to ensure comparability of results. The results of this review indicate that BC levels in OSP are not severely impacted by the most common food processing techniques. OSP should continue to be a strong food-based intervention for prevention of vitamin A deficiency in women and children in developing countries.

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Introduction

The Honduras Children’s Micronutrient and Deworming Project was a 3-year (July 2006–June 2009) project jointly implemented by Vitamin Angels (VA) and Cristo Salva. With the support of SIGHT AND LIFE, this campaign-style intervention sought to provide essential multiple micronutrient supplements (EMMNS) to children aged 2–14 years in selected schools in the northwestern region of Honduras. The children were given a daily supplement for an average of 180 days per year, which is the number of school days in the academic year. In addition, the children were given 400 mg of the deworming drug, Albendazole, twice a year. This project was designed as part of a larger Honduran Ministry of Health (MOH) rural health program that brings preventive and therapeutic care to the regions served by this project.

Problem and need

Growth stunting among children is recognized as an indicator of chronic malnutrition. In 2006, the World Health Organization (WHO) reported that 29.9% of underfive children in Honduras were stunted.1 According to Honduras’ Ministry of Health (MOH), the highest prevalence of stunting and underweight in children occurred in the rural west region as a whole.3

Parasitic infection contributes to malnutrition, particularly among children entering school, who are the most vulnerable to soil transmitted helminthes (STHs). The Pan American Health Organization (PAHO) reported in 2006 mild parasitic infection rates of 40.4% in the northwest region of Santa Barbara State – the highest rate of moderate infections among PAHO study locations.4 The net effect of these conditions is that growth, development, and school performance are significantly affected. For the last several years, the

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Children in Macuelizo, Honduras
MOH has worked to provide nutritional supplements and anti-parasitics to vulnerable children. However, coverage rates have been inconsistent across regions and communities due to limited funding for nutritional supplements and deworming agents.

**Honduras Children’s Micronutrient and Deworming Project**

To combat the significant levels of chronic malnutrition complicated by STH infections, the Honduran Government requested assistance to provide micronutrient supplementation and deworming agents for the entire northwest region of Honduras, and identified a target of 55,000 children at 88 schools in four districts of northwestern Honduras (Macuelizo, Azacualpa, Nueva Frontera, and Quimistan). With support from SIGHT AND LIFE, VA offered to sponsor the Honduras Children’s Micronutrient and Deworming Project. Under this project, VA partnered with local NGO, Cristo Salva, to design an intervention that enabled teachers to deliver nutritional supplements each school day and Albendazole once every six months to eligible children.

The project further provided an additional supply of nutritional supplements to the parents of school-going children in order to reach their preschool-aged children. To reach eligible school-aged children who are not enrolled in school (out-of-school children), an outreach program supplied the supplements and anti-parasitics to local intermediaries who distributed them to the children. The project also arranged for adult family members to be educated, through the school system, in the preparation and use of local foods rich in vitamin A as well as in gardening, sanitation, and basic hygiene.

The project aimed to achieve at least 70% coverage of all children aged 2–14 years (i.e., all children enrolled in school) in the project’s geographical areas during the school year with the nutritional supplements, which were provided during school sessions. The project also set out to achieve at least 70% coverage of all children aged 2–5 years living in the same households as the school-going children.

For planning purposes, all children were targeted to receive, as appropriate, both a daily nutritional supplement throughout the school year and Albendazole twice a year for three years. By achieving this level of coverage in the target population, the project sought to reduce the prevalences of parasitic infections, stunting, anemia, vitamin A deficiency, and chronic malnutrition, as well as reduce clinic visits and hospitalization, increase school attendance, decrease morbidity and/or mortality rates, and improve school performance.

Over the three years of the Honduras Children’s Micronutrient and Deworming Project, nearly 100% of school-going children (a total of 26,034 children aged 2–14 years), attending 88 selected schools in the four project districts, were reached annually with both nutritional supplements and deworming tablets. The

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of micronutrient capsules distributed</th>
<th>Number of deworming tablets distributed</th>
<th>Number of children served</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 (1/2 year)</td>
<td>4,000,000</td>
<td>30,000</td>
<td>35,000</td>
</tr>
<tr>
<td>2007</td>
<td>8,982,800</td>
<td>30,000</td>
<td>55,000</td>
</tr>
<tr>
<td>2008</td>
<td>10,393,600</td>
<td>110,000</td>
<td>55,000</td>
</tr>
<tr>
<td>2009 (1/2 year)</td>
<td>4,411,400</td>
<td>NA</td>
<td>55,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27,787,800</strong></td>
<td><strong>170,000</strong></td>
<td><strong>55,000/year</strong></td>
</tr>
</tbody>
</table>
The project also reached approximately 75% of associated, eligible pre-school children aged 2–5 years (approximately 29,000 children), living in the same households as the school-going children with the same regimen.

**Key findings and lessons learned**

*The project design was effective in achieving the targets.* Based on the overall project design, VA and Cristo Salva reached approximately 35,000 school-children in the four project districts during the first six months of implementation. In the second six months, implementation was scaled up and the target of 55,000 children (including both school-going and out-of-school children) was reached and continued to be reached from 2007 onward. Thus, all numerical targets were met or exceeded by the project intervention.

*The results were validated by the MOH.* The project objectives were to mitigate the effects of deficiencies of essential micronutrients, eliminate parasites, and thereby improve the absorption of micronutrients. Observational and anecdotal accounts from parents and teachers collected by both the MOH and Cristo Salva, combined with MOH survey data, indicate that the children have shown improvements in health, growth, and attentiveness in class.

*The distribution mechanism and effective monitoring served the project well.* Teachers and local intermediaries, also known as the local health *prometeras*, were able to successfully carry out distributions to reach children as intended by the program. Close contact was maintained with distribution agents by the Cristo Salva project coordinators, and monitoring of the distribution became routine. The Cristo Salva program director and staff regularly visited the distribution locations and collected information, including photographs, records, and beneficiary lists. For those few schools discovered not to be completing their obligations fully, as evidenced from monitoring, feedback from the program director resulted in improvements and helped this public-private partnership to surpass its targets.

*Integrated relationships among different programs facilitated success, but there is a need for continuity.* The Honduras Children’s Micronutrient and Deworming Project is integrated with a larger MOH program (largely designed, funded and implemented by Cristo Salva) that seeks to improve the long-term nutritional status of children in Macuelizo and surrounding regions. The strategy is contained in a two-phase approach. The first phase is to address the immediate crisis: chronic malnutrition. Essential nutritional supplements and anti-parasitics are deemed to be an effective foundational strategy to achieve positive outcomes rapidly. The second phase is to enable policies and programs that ensure sustainable means for a community’s good health and micronutrient status. Tactically, this entails supporting nutrient-rich gardening among communities and schools; on-going education on available red, green, and orange leafy fruits and vegetables that supply vitamin A and other essential nutrients; and education on hygiene, sanitation, water and nutrition in schools and through community outreach. Thus, the MOH and Cristo Salva have an overall strategy to move from immediate interventions to abate the nutritional crisis to a longer-term set of policies and programs to alleviate the underlying causes of malnutrition.

The district of Azacualpa has proven particularly successful in realizing both short and longer-term objectives within this strategic framework designed to eliminate malnutrition. In addition to compliance with micronutrient supplement distribution under this project, the district schools have been at the forefront of education on nutrition and good health. They have planted and maintained school gardens, including a tilapia fish farm. Dental care has been instituted, and water filters are being installed in all of the schools.
Teachers in all areas are reporting a decrease in absenteeism, and an increase in student activities. They cite the provision of nutritional supplements and anti-parasitics as an important part of the increasing engagement with health and nutrition issues by both students and parents.

The overall MOH/Cristo Salva framework helped to frame the tactical implementation of this project while assisting in the mobilization (especially by Cristo Salva) of resources to achieve longer-term goals – as is demonstrated to be occurring in Azacualpa District. It is important to note, however, that the longer-term goals will not be achieved according to the rapid schedule set at the start of the project. While the MOH is making significant progress, it also acknowledges that the tasks associated with the strategic plan it has put in place are more costly than expected and will take longer to achieve than expected. Consequently, there are reasons to continue to maintain this program for another three-year period. This experience is in line with WHO experience in other countries – while there is general progress being made to bring about change to nutritional status, supplementation programs remain easy to implement, effective, and fulfill a significant role in helping governments to fulfill their longer-term objectives. Supplementation programs are increasingly being viewed as an essential intervention to move governments toward better nutritional status for their populations, yet are required for longer-than-expected periods.

Conclusion and recommendation

Through steady execution of this project, undertaken in the context of a larger Honduran Government plan to alleviate malnutrition, this project has met with considerable success in fulfilling the MOH’s objective (and the project objective) to quickly reach large numbers of children through a locally designed supplementation and deworming project to alleviate the immediate problem of micronutrient deficiency. Anecdotal evidence suggests progress has been achieved among the target beneficiaries.

Unfortunately, the cost and effort anticipated by the Honduran MOH to alleviate malnutrition through a two-stage effort (i.e., use of supplementation and deworming programs in advance of longer-term interventions to alleviate malnutrition) is proving to be greater than anticipated. The MOH is making progress in implementing its longer-term strategy to eliminate malnutrition, but it believes that supplementation and deworming efforts will need to be in place for several more years until its longer term interventions take hold. This experience is not dissimilar to that found in other countries and there is a growing consensus that supplementation and deworming projects will need to continue for significantly longer periods than previously anticipated. Consequently, there is a desire on the part of the Honduran MOH to continue this successful project for another three-year period – an assessment with which VA agrees. VA intends to support this project for another three years.

References

Africa Forum 2009: Sharing Integrated Solutions to HIV and Food and Nutrition Insecurity

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The Africa Forum 2009 (AF09) was held on the shores of Mangochi, Malawi, on June 21–26, 2009, on the theme of Sharing Integrated Solutions to HIV and Food and Nutrition Insecurity. Attended by 170 Africans from 18 sub-Saharan African countries, the Forum was a practitioner-led, non-academic conference on the integration of food, nutrition, and livelihood security (FNLS) with HIV/AIDS. This is the second Africa Forum to be held, after the inaugural Africa Forum in Zambia in 2006 on the theme An Integrated Response to the Dual Epidemics of HIV/AIDS and Food Insecurity. The Declaration produced during that conference laid the foundation for AF09, outlining key priorities in the realm of integrated HIV and food and nutrition security programming for the future, namely:

• Making the integration of HIV/AIDS and FNLS a priority
• Increasing learning & information sharing on integrated programs
• Decision-making about integrated programs is guided by those most affected

These priorities formed the basis of three, interlinked and complementary components of what subsequently became the Links for Life Initiative:

1. Africa Forum 2009: Inter-country sharing to improve skills and knowledge in integrated programming and to facilitate the scaling-up of promising interventions;
2. Communities of Practice (CoPs): Promotion of field-based learning and knowledge generation on emerging practices in Malawi and Ethiopia; and

AF09 attendees actively participated as presenters, panelists, and facilitators with high levels of commitment, and clearly yearned for learning on integrated HIV and FNLS. Over the course of the week, their enthusiasm seemed to grow, despite being overwhelmed at times with so many concurrent sessions, group work sessions, and hands-on activities. According to evaluations, participants left AF09 strongly motivated to do things differently, not only programmatically, but also in terms of how they would organize planning meetings, trainings, workshops, and conferences, going forward.

Impact at individual, household, and community levels

On a daily basis throughout sub-Saharan Africa, AF09 practitioners are faced with the fact that millions of people living with HIV (PLHIV) are becoming ill and dying prematurely, not only from the lack of advanced medicines but also because of health problems associated with poor nutrition, inadequate access to food, and preventable illnesses. While the region is home to only 10% of the world’s population, it hosts 60% of the global population living with HIV. Simultaneously, the region is defined by chronic food insecurity and malnutrition, with an estimated 206 million people chronically hungry and malnourished (UNAIDS, 2007).1 In
addition, the 2008 global food crisis has pushed even more Africans into chronic hunger, making the United Nations Millennium Development Goal to reduce the number of people worldwide suffering from hunger by 50% increasingly remote. Food, nutrition and livelihood security are essential elements to successfully mitigate the impact of HIV/AIDS on individuals, families, and communities. HIV and malnutrition are inextricably linked at each level and require integrated solutions if impact is to be alleviated.

Impact at individual level

HIV and malnutrition have a synergistic relationship. HIV undermines food and nutrition security, just as malnutrition thwarts efforts at HIV prevention and treatment. Experience and research have shown that activities aimed at immune system strengthening and the prevention of malnutrition in PLHIV can extend the average asymptomatic period by four to six years.\(^2\)

This is supported by evidence that micronutrient supplements, providing the recommended daily allowance of vitamins and minerals, slow the progression of HIV.\(^3\) Prolonging the latent period not only brings valuable years of health to PLHIV and their children, it can also delay the need for antiretroviral therapy (ART) among those infected; reduce the cost of treatment; and provide time for overburdened health systems to build the capacity needed to meet demand. When ART is needed, having access to food and good nutrition helps ensure drug adherence. AF09 participants shared anecdotal reports about each of these situations. Individuals who start ART when malnourished suffer more severe side effects than those who are sufficiently nourished. These side effects — which include nausea, taste changes, diarrhea, vomiting and loss of appetite — threaten to decrease adherence to drug regimens, speeding the development of drug-resistant strains of HIV as individuals start and stop treatment. One study asserts that PLHIV who start ART when malnourished may be up to six times more likely to die than their well-nourished counterparts.\(^4\) In Malawi, as ART scaled up, reports showed very high mortality rates with 71% of clients dying during the first three months with malnutrition as a major contributing factor.\(^5\)

Impact at household level

AF09 practitioners also know all too well how HIV also undermines livelihood security. When PLHIV become sick, the impact of the disease reduces households’ asset base and labor supply, promotes labor reallocation from agricultural production to other areas (e.g., care and support), and decreases overall productivity. The majority of countries in the sub-Saharan region are agro-based economies, with agriculture contributing upwards of 85% of the GDP; Malawi serves as a primary example. Traditional methods of farming are labor intensive and difficult for PLHIV to sustain. To survive, those infected with HIV and their families often turn to destructive coping mechanisms, involving high-risk behaviors and/or environmental degradation, such as using natural resources to produce and sell charcoal.

At the household level, illness and the premature death of parents have created a generation of orphans who will grow up unsupervised and take on adult responsibilities, such as caring for and feeding younger siblings and ill family members. In the absence of parental guidance, the agricultural and life skills ordinarily passed down from parent to child are no longer transferred, undermining the ability of these youths to pursue productive livelihoods.

Impact at the community level

At the community level, fewer adults are able to harvest crops, earn income, and contribute to the well-being of the more vulnerable members of society, thus weakening the fabric of traditional community safety
nets, which were once a staple feature of African societies. The convergence and dual impact of HIV and food insecurity has also decimated the capacity of governments to retain skilled staff and volunteers and, ultimately, to provide basic health care to its citizens at the community level. This constrains the ability of health centers to roll out antiretroviral drugs as well as provide programs on nutrition education and the rehabilitation of malnourished individuals. Government officials from the majority of countries represented at AF09 participated in order to learn from their peers around the continent and support continued learning in their own countries upon returning home.

Building capacities of adult learners

In order to build individual and organizational capacity to implement and scale up quality integrated HIV/FNLS programs throughout sub-Saharan Africa, AF09 showcased models that would reduce high-risk behaviors of people, extend the asymptomatic period for PLHIV, and help communities mitigate the overall impact that food, nutrition, and livelihood insecurity combined with HIV has on community well-being and development.

The AF09 program included plenary sessions, debates, skills building workshops, program site visits, cluster presentations, panel discussions, morning motivational speakers, country-specific CoP planning sessions, and opportunities for networking and relationship building. Even the main address was unique, delivered as a ‘musical keynote’ by Oliver “Tuku” Mtukudzi, a best-selling African artist. Recording since the mid-1970s, Tuku has produced more than 40 albums with undeniably contagious music and lyrics. Singing with his son, Sam, at AF09, Tuku featured his original songs that address the HIV epidemic with a sense of realism, humor and optimism. The inspiring keynote set the tone for the week.

Communities of practice

During the week, AF09 participants took part in interactive learning methodologies and hands-on skill building sessions to enhance their capacity to implement integrated programming. To sustain learning on integrated programming in specific country contexts after the Forum, AF09 helped to facilitate the creation of country-based mechanisms to help practitioners – including government representatives – to scale up promising practices in their own countries.

In 2007, in response to requests for assistance, and in an effort to be responsive to the AF06 Declaration to create inter-country learning, Project Concern International (PCI) designed the Links for Life Communities of Practice (CoP) and sought funding from sister organizations. Two CoPs, also known as learning communities, were established in Ethiopia and Malawi. Led by experienced facilitators hired by Links for Life, CoP members from NGOs, government and academic institutions working in HIV and FNLS programming shared their programmatic experiences and documented what they learned from being part of the CoP. The CoP learning and planning process was a thread woven throughout AF09.

The Ethiopia and Malawi CoP coordinators and a handful of CoP participants (i.e., 12 from Malawi and 7 from Ethiopia) collaborated to develop and facilitate various sessions throughout the week. The purpose of these plenary and breakout sessions was to build the capacity of participants in establishing a CoP – or similar mechanism – in their own countries to continue and sustain learning. The ‘A to Z’ of establishing and maintaining CoPs, and the specifics of how they operated in Ethiopia and Malawi were shared through a ‘how-to’ guide, videos of the Malawi and Ethiopia CoP experiences, personal testimonies, plenary sessions, and skill-building seminars.

We are what we eat

AF09 strove to practice what it preached by ensuring that all meals offered at the conference were highly

Learning first hand about the role of aquaculture
nutritious. Specifically, the menu was designed to reflect a diet for anyone wanting to eat the healthiest foods available while protecting the environment. Toward that end, with generous support from GTZ/Malawi, a permaculture garden was established at the venue, known as Sun 'n' Sand, and specific technical assistance provided to venue staff. A permaculture expert and long-time Malawi resident, June Walker, coached Sun ‘n’ Sand staff on how to establish and maintain the garden, as well as how to replicate it at their homes. Dubbed ‘We Are What We Eat,’ the garden and corresponding AF09 menu were developed to contribute to:

• Supporting the supply of organic foods grown on-site for AF09 participant consumption while making the most out of local natural resources;
• Ensuring the availability of micronutrient-dense food choices, such as herbal teas, fruits, vegetables, spices, legumes, nuts, herbs, dairy, and other appropriate foods, as listed in the guide, Food for People Living with HIV; and
• Facilitating food preparation methods that conserve nutrients, such as steaming, preparing raw food, and baking, and avoiding overcooked and fried foods.

Lunch and tea break menus consisted of food produced in the permaculture garden. During an AF09 plenary session, June and her local Malawian counterparts – Samuel Baruti and Amos – described the steps they took to prepare food for AF09 participants. Starting with the garden, they explained how the soil in a permaculture garden does not require tilling, and that it can be prepared from seeds with compost made from local manure. As standard with permaculture gardens, all types of fertilizers and chemicals to treat plants were avoided, and natural insect repellents were used. Seeds and seedlings were planted in pumpkin shells to help nurture them, using biodegradable toilet paper rollers for support rather than polythene or other types of tubes.

Members from the community initially laughed at the permaculture gardeners, saying that the compost heaps looked like “earth tombstones.” Later, however, the same individuals started to appreciate and admire the vegetables and fruits produced in the garden. The head chef at Sun ‘n’ Sand explained how he used produce from the garden to prepare meals for AF09 participants each day. He also talked about how important it is to eat different types of food for
good nutrition, and encouraged everyone to visit the garden. Truly, this was a very unique and sustainable part of AF09 that each participant enjoyed. The garden will continue to benefit not only the staff from the venue, but also local community members who observed the process from the beginning and learned how to replicate it if they so choose.

In keeping with the spirit of demonstration and hands-on learning, a ‘Taste and Touch’ session was also organized to introduce local dishes and nutritious foods for PLHIV from various African countries. The session featured recipes from eight African countries (Ethiopia, Ghana, Kenya, Malawi, Rwanda, South Africa, Zambia, and Zimbabwe), and ranged from natural teas and biscuits to easy-to-ingest soya-sorghum-rich meals. Facilitators shared the recipes and preparation methods during the session. Delegates also received a recipe booklet with all the recipes from the session.

Application of learning post-AF09

Since June, personal testimonies have been shared by AF09 participants about how they are applying what they learned at the Forum. For example, a member of the Malawi Defense Force (MDF), Lt Davie Jones Gondwe, attended AF09 on behalf of the Umodzi HIV-positive support group that he and his barracks had been supporting. The Malawian military had provided the Umodzi Support Group with land at their barracks for gardens and a fish pond. The garden produced sufficient quantities of vegetables and fruits to strengthen the food security of families in the network, along with the salaries of three civilian gardeners, and a person to maintain the fish pond.

There were structural problems with the group’s first pond, however, resulting in the loss of fish and water.

Upon returning from AF09, Lt Gondwe used skills acquired at AF09 to provide aquaculture technical assistance, including pond maintenance, and the use of improved fish feed to reduce time-to-harvest from six to four months. He also worked with the Umodzi Support Group to expand their project to include a second fish pond. The construction of the pond has been financed by contributions from the network’s membership of PLHIV, with the expectation that they would reap the benefits of future fish harvests.

Lt Gondwe has been recognized by the MDF for his efforts and appointed to be its national program coordinator for HIV/AIDS to showcase the successes to other barracks around Malawi. Thus far, he has provided technical assistance on fish farming at three other barracks, and it is expected that aquaculture will be scaled up in other areas of the country over the coming year.

This example is only one of many where AF09 participants have taken their learning forward from the event into their work and daily lives. Indeed, at the next Africa Forum, there will be much to share on the progress made in scaling up successful integrated programs for individuals, households, communities, and hopefully countries as well.

References

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Quotes

“We’ve definitely moved forward. Whereas in Africa Forum 2006 we were talking about the need for integration, now we are talking about key issues that we find in integrated programs. In addition, in 2006 we were all looking for ideas and advice. AF09 has shown an outstanding level of expertise in many areas – expert implementers, not directors or advisors, but the implementers themselves! We are moving forward.”

– Africa Forum 2006 participant attending Africa Forum 2009

“I am grateful to be accorded an opportunity to share a story on behalf of the women of Malawi – those that have no voice – and hope that, one day, they can be afforded this opportunity to share their stories.”

– AF09 participant
Micronutrient Forum Satellite Session Highlights

Scaling Up Maternal, Infant, and Young Child Nutrition Programming

More than 85 people participated in Scaling Up Maternal, Infant, and Young Child Nutrition (MIYCN) Programming, a satellite session at the Micronutrient Forum in Beijing, China, on May 11, 2009. The meeting, sponsored by the Global Alliance for Improved Nutrition (GAIN); the University of California, Davis; the United States Agency for International Development (USAID); and USAID’s Infant & Young Child Nutrition (IYCN) Project, led by the Program for Appropriate Technology in Health (PATH), brought together a wide range of conference participants and members of the MIYCN Network, a group of individuals working toward integrated programming for MIYCN.

The session emphasized the importance of an integrated approach for addressing nutritional needs during the important life cycle window from preconception through two years of age. Speakers representing government, nongovernmental organizations, universities, and the private sector presented successful approaches to identify and address the problem of malnutrition through the life cycle. Presenters discussed a wide variety of integrated solutions that have achieved results in Thailand, Bangladesh, Honduras, Malawi, and other countries.

During closing remarks, USAID’s Frances Davidson said that although the consequences of malnutrition are overwhelming, it lacks support and funding compared to other diseases such as HIV/AIDS and malaria.

“Since malnutrition is not as easily identifiable as other diseases and conditions – despite the important role it plays in dealing with diseases in the long term – it has been given less attention and fewer resources,” said Dr Davidson.

Dr Davidson said that the session’s emphasis on solutions to improve nutrition highlighted the intergenerational deficits of malnutrition that can be overcome. Participants agreed that addressing the problem will require a long-term view by policymakers, financial planners, and politicians, as well as the public health community.

The MIYCN Network will continue to hold regular meetings to discuss scale-up of MIYCN programming. Next steps include looking at further documentation of delivering science in nutrition – translating knowledge into action to ensure all children achieve their potential.

Visit the Infant & Young Child Nutrition Project website to download selected presentations: http://www.iycn.org.

Keynote address

Dr Kathryn Franko of the University of Auckland gave the keynote speech. She discussed the relationship between poor health outcomes in all individuals, including men, and malnutrition in women, infants, and young children. Malnutrition in pregnancy affects the nutritional status of the unborn baby, often resulting in low birth weight — which later affects health and nutrition wellbeing and productivity in early childhood, school-aged children, and in adults.
How Thailand reduced national rates of malnutrition

Dr Pattanee Winichagoon of Mahidol University in Thailand presented a case study about Thailand’s successful efforts to reduce national rates of malnutrition. Strong leadership, advocacy efforts, mass media campaigns, and community-based approaches contributed to rapid and continued improvements in nutritional status. Figure 1, below, shows the decrease in the prevalence of protein-energy malnutrition in the country from 1989 to 2001.

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Prevention of Anemia in Women of Reproductive Age (WRA) with Weekly Iron and Folic Acid Supplements (WIFS)

The satellite session on the Prevention of Anemia in Women of Reproductive Age (WRA) with Weekly Iron and Folic Acid Supplements (WIFS), was sponsored by the World Health Organization (WHO) and shared the conclusions of a WHO Global Consultation and program outcomes on this topic.

Juan Pablo Pena-Rosas, of WHO, presented on his organization’s Position Statement on WIFS for WRA, specifically its role in promoting optimal maternal and child health. This was an outcome of a WHO Global Expert Consultation on WIFS for Preventing Anemia in WRA convened in Manila, Philippines, in 2007. Fernando Viteri, of Children’s Hospital Oakland Research Institute (CHORI), described studies examining high iron intake during recovery from iron deficiency. Among his key points were that WIFS should be continuous rather than periodic and food fortification programs should be complemented with WIFS for WRA. Sheila Vir described case studies on WIFS among adolescent girls in India, with specific reference to a study in Uttar Pradesh (Table 1). Key points were that the WIFS reduced anemia prevalence significantly within 6 months and, hence, it is a cost-effective intervention for adolescent girls, whether in school, under supervision or unsupervised.

Tommaso Cavalli-Sforza, presented on WIFS in Cambodia, the Philippines and Viet Nam, targeting about 30,000 WRA per country for 12 months with the aim of being able to apply a common protocol. In all three countries, WIFS were well accepted and most women were willing and able to purchase WIFS for an affordable price and there were major improvements in knowledge and practices, in all countries, including improved diets. Results differed in each country with the best outcomes in Viet Nam, where anemia decreased by 50% or more, in both non-pregnant and pregnant women who took WIFS (p < 0.01), while iron deficiency anemia decreased from 9% to 1% in non-pregnant women.

Figure 1: Prevalence of protein energy malnutrition among children aged 0–60 months in Thailand from 1989 to 2001
Bounthom Phengdy presented on a WIFS program for WRA in the Sekong Province of Lao PDR, which led to an overall significant reduction in the prevalence of anemia from 43% to 23%. Based on this, WIFS are planned to be included as part of the essential package for maternal and child care under the Lao National Nutrition Strategy and National Plan of Action on Nutrition.

Dr Vir and Dr Cavalli-Sforza concluded the session with a discussion on best practices for the implementation of anemia prevention programs among WRA with WIFS, highlighting the need to ensure political commitment, uninterrupted and accessible supplies of supplements, effective distribution, and appropriate communication.

In 2008, WHO adopted a new methodology to systematically develop evidence-based recommendations using systematic reviews and the ‘Grading of Recommendations Assessment, Development and Evaluation’ (GRADE) methodology to evaluate the quality of the evidence and the strength of the recommendations (Figure 2). The process requires: 1) constitution of a technical guideline development group to assist WHO to refine the question/scope of the guideline, 2) systematic synthesis and assessment of the evidence, 3) formulation of the evidence, and 4) dissemination of recommendations, and 4) disseminating the guidelines. The quality of the evidence is evaluat-

<table>
<thead>
<tr>
<th>States</th>
<th>Age (years)</th>
<th>Coverage</th>
<th>Anemia prevalence (baseline) relative to baseline</th>
<th>Percent change in anemia prevalence (12 mo)</th>
<th>WIFS Compliance (%)</th>
</tr>
</thead>
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<tr>
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<tr>
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<td>77,000</td>
<td>73,700</td>
<td>73.3</td>
<td>34.3</td>
</tr>
</tbody>
</table>

Table 1: Results from four case studies in adolescent girls in India

![Figure 2: WHO’s methodology to systematically develop evidence-based recommendations](image-url)
ed using various criteria in four categories from very low to high quality. The relative strength of a recommendation is assigned as ‘strong’ or ‘weak’ based on the quality of evidence, balance between desirable and undesirable effects, values and preferences, and costs (resource allocation).

The WHO’s position statement on WIFS for WRA can be found at: http://www.who.int/nutrition. It is anticipated that the recommendations in this statement will remain valid until December 2010. WHO will then be responsible for initiating a review following their formal guideline development process.

The outcome of the process will feed into the WHO E-Library for Nutrition Programme Guidance: Recommendations, Evidence and Best Practices, a multi-partner project bringing together WHO departments, programs, regional and country offices, and external partners, including UNICEF, WFP, FAO, CDC, GAIN, MI, and Cochrane. The collaboration will be a long-term commitment to update recommendations, evidence and best practices to find innovative nutrition interventions to effectively address the Millennium Development Goals (MDGs).

Flour Fortification Initiative – Flour Fortification Recommendations

Mary Sedula introduced the topic of flour fortification and highlighted that the major advantage of a fortified product is that it can be delivered through existing systems, which mill 400 million tons of wheat flour per year for human consumption. A 2004 technical workshop on wheat flour fortification with iron and folic acid concluded that the addition of iron and folic acid to wheat flour is a feasible, affordable, and effective strategy to reduce the prevalence of important micronutrient deficiencies. This was followed by a second technical workshop in 2008 on practical recommendations for national application of the recommendations to give guidance on the fortification of flour with zinc, iron, folic acid, vitamins A and B12. Expert groups on each micronutrient prepared background documents and draft recommendations, which were discussed and approved by WHO. The satellite meeting was an opportunity to summarize the outcomes of the workshop to a wider audience.

Iron working group

Ralf Biebinger presented on the development of recommendations for the iron fortification of wheat flour. The group evaluated to what extent the flour industry is following the 2004 guidelines, and adjusted the guidelines based on recently published efficacy studies and more realistic flour intake patterns. Currently, only 9 out of 78 programs are likely to have significant positive effect on iron status at the national level. Many countries do not specify iron compounds and millers use poorly bioavailable H-reduced and atomized elemental iron powders. Some countries specify non-recommended iron powders, have too low fortification levels, poor coverage or low flour consumption. Strategies are needed to encourage governments to modify legislation and millers to follow guidelines.

Zinc working group

Ken Brown presented on current recommendations and research needs relating to zinc fortification of cereal flours, noting that little work has been done on the efficacy of zinc. However, preliminary data from China, where zinc oxide was added to flour with EDTA iron or elemental iron, showed improvements in serum zinc concentrations after three years. Zinc fortification of cereal flour with zinc oxide or zinc sulphate is a safe, effective and low cost method to increase zinc intake, total absorbed zinc, and (in selected population groups) zinc status. Zinc fortification should be included in flour fortification programmes in countries with an elevated risk of zinc deficiency if flour is consumed in sufficient amounts by target groups.

Vitamin A working group

Keith West presented for the vitamin A working group, highlighting that wheat and maize flour can technically be fortified with vitamin A and that vitamin A is stable in flour without producing organolep-
tic changes. Experience with vitamin A fortification of wheat and maize flour in developing countries is increasing. Although vitamin A is most often used in the fortification of oils and fats, currently 11 countries are fortifying or propose to fortify wheat and/or maize flour with this vitamin. Two published efficacy trials have reported the impact of vitamin A fortified wheat flour on vitamin A nutritional status but there are no published studies that have evaluated the effectiveness of this intervention on a national scale. Nutritional surveys are needed to establish the vitamin A intake and wheat flour intake of vulnerable groups but it will be necessary to consider high consumers in the calculations.

Folic acid working group

Dr Berry also presented for Lindsay Allen for the discussion on vitamin B_{12} fortification of flour. The reasons to consider the fortification of flour with vitamin B_{12} include the low intake of animal-source foods in many communities resulting in deficient and marginal plasma B_{12} in 40–80% people of all ages. There is an increase in depletion and deficiency associated with aging, even in wealthier countries, due to food cobalamin malabsorption. Many adverse health outcomes can result from B_{12} deficiency including anemia, neuropathy. Those who would benefit most from B_{12} fortification in developing countries include low consumers of animal-source foods and, in wealthier countries, low consumers of animal-source foods who do not eat fortified cereals or take supplements. B_{12} deficiency is prevalent because of low intake of animal-source foods, affecting all ages. Consequences of severe – and possibly of marginal – deficiency are serious. Efficacy and effectiveness need confirmation, including in elderly people with gastric atrophy.

Juliet Aphane presented for FAO, which views food fortification as one of the effective strategies in reducing micronutrient deficiencies. She highlighted the need to consider the conditions of the vulnerable whose micronutrient deficiencies cannot always be addressed by fortified products,
including poor subsistence farmers whose main food supplies come directly from the land and have restricted access to fortified foods, people with low purchasing power and undeveloped purchasing channels, and those with multiple micronutrient deficiencies that cannot all be addressed by fortified foods. In this context, FAO pursues the goals set by governments as priority for overall nutrition improvement through food-based approaches, with emphasis on dietary diversity; and also assists governments in ensuring that food fortification programs find their appropriate place as one element of national nutrition improvement policies, plans and programmes.

Regina Moench-Pfanner, presenting for GAIN, reiterated GAIN’s commitment to reducing malnutrition through food fortification and other strategies aimed at improving the health and nutrition of populations at risk. Large scale funding for flour fortification began in 2003 and the first technical workshop was held in 2004. Government and industry partners face many challenges in procuring premix for food fortification programs, including high premix costs and lack of a system to ensure the product’s quality. To address these barriers, GAIN is developing and implementing the GAIN Premix Facility, which consists of four components: a certification process that establishes industry-wide standards and quality guidelines for premix; a procurement facility that makes premix more easily accessible to countries and the private industry engaged in fortification; revolving funds that will help projects finance their premix purchases; and a grant mechanism that provides premix for fortification of food products used to reach vulnerable groups, including public sector programs and emergencies.

Considerations for the Safe and Effective Use of Iron Interventions in Malaria-Burdened Areas

A satellite session was convened by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) of the US National Institutes of Health (NIH) and the World Health Organization (WHO) to present a state-of-the-science technical report entitled ‘Considerations for the safe, effective use of iron interventions in areas of malaria burden.’ The report, co-funded by the Bill and Melinda Gates Foundation (BMGF), was drafted by a Technical Working Group (TWG) constituted to address three core areas related to iron and its potential interactions with malaria: mechanisms, biomarkers, and interventions. The technical report was created as part of a larger project conducted by NICHD, and co-funded by BMGF, to address issues surrounding current strategies to ameliorate iron deficiency.

The meeting was opened by Francesco Branca, WHO Director of the Department of Nutrition for Health and Development (NHD), who served as the session chair and panel moderator.

Daniel Raiten, Project Officer at the NICHD, provided the background for the larger iron and malaria project, which aims to address historical concerns about potential adverse interactions between iron and infection, particularly malaria. The key questions to be addressed by this project are: 1) Does iron deficiency predispose to or protect against malaria and other infections? 2) Does the correction of iron defi-
iciency raise or lower the risk of malaria and other infections? 3) Do iron interventions increase or decrease the risk of malaria and other infections? The full technical report authored by the TWG and the project Secretariat at the NICHD is expected to be published as a WHO monograph. As part of its process for developing new guidance, WHO, in collaboration with NICHD, is planning to host a consultation in 2010 at a location impacted by iron deficiency and malaria.

Gary Brittenham, of Columbia University, presented an overview of the potential mechanisms underlying adverse effects of iron interventions in the context of malaria. Dr Brittenham discussed the conclusions of the TWG with regard to the Pemba study of universal iron and folic acid supplementation in children as follows. In summary, the technical report concluded that, overall, iron deficiency seemed to increase susceptibility to malaria and other infections, not to provide protection. More research is required to determine the nature of the interactions of iron status and iron interventions with infection to determine the exact mechanisms of adverse effects in the context of malaria.

Sean Lynch, of Eastern Virginia Medical School, presented on the use of biomarkers to assess iron status. The indicators covered in the report include hemoglobin, serum iron/transferrin saturation, zinc protoporphyrin/heme ratio (ZPP/H), serum ferritin, soluble transferrin receptor and transferrin receptor/ferritin ratio. The experimental indicators are hepcidin (urine and plasma) and NTBI (Non-transferrin-bound iron). Dr Lynch summarized the report’s conclusions by noting that transferrin receptor/ferritin ratio should be the standard assessment tool where the prevalence of malaria and other chronic infections is relatively low or seasonal. He suggested that the results of serum ferritin, an acute phase reactant, can be compromised in the presence of inflammatory or infectious diseases.

Kathryn Dewey, of the University of California Davis, discussed the safe and effective use of currently available iron interventions. Dr Dewey shared the TWG conclusions that the provision of iron via tablets or liquids requires caution and may offer the least desirable approach in malaria endemic areas. Fortified foods, including iron fortification (central or home) of complementary foods for infants and young children and of staple foods or condiments for women and older children, may be the most viable alternative intervention. Although there are few studies that have specifically addressed the issue, the TWG concluded that there is little evidence to suggest that iron-fortified foods are not safe in such areas.

Juan Pablo Pena-Rosas, Micronutrients Unit, NHU/WHO, outlined the WHO Guideline Development Process as it relates to the use of the technical report and the overall goals of the iron and malaria project. WHO’s role is to translate evidence into WHO Guidelines for Member States and their partners. Among the questions for iron and malaria are: definition of the population at risk, prioritizing interventions under study (including consideration of dose, duration, and form), determining appropriate comparison groups, and deciding on key primary outcomes.

Workshop for the Design, Legal Framework Formulation, Control and Monitoring of Food Fortification Programs

The satellite session convened by A2Z aimed to describe the elements that experience has shown are crucial to the success of food fortification programs. Carol Tom, from A2Z, welcomed everyone and introduced the speakers: Dr Richard Hurrell, who was presenting Dr Lindsay Allen’s talk, Dr Omar Dary and Dr Hector Cori.

Richard Hurrell, ETH Zurich, presented on behalf of Lindsay Allen on the biological and scientific
issues in food fortification programs. Examining how to decide whether fortification is needed, and how much, the first step that is needed is to provide documented evidence that the micronutrient content of the diet is insufficient and may be improved by the implementation of a fortification program, or that fortification will provide a health benefit. Biochemical assessment of micronutrient status and dietary assessment of food vehicle intake are needed to provide such evidence.

Omar Dary, A2Z, presented on the elements for successful and effective fortification programs, highlighting the dynamic cycle of the functional components of a food fortification program, which includes scientific assessment, design (national policies, standards), implementation (fortification process, premix production), supervision (quality control/assurance), consumption (social marketing), impact assessment (measurement of biomarkers), and cost-effectiveness. His key points were that food fortification should respond to the assessed need (severity and prevalence), potential impact is dependent on additional intake and coverage of the incorporated micronutrients, and standards should be constructed based on averages, plus an analytical accepted range determined experimentally for each food vehicle, process, sampling method, and chemical methodology.

Hector Cori, DSM Nutritional Products, presented on quality as a critical driver for program effectiveness. Describing the critical quality issues relating to the fortification programs, he highlighted that the importance of ingredient quality is often missed, although international guidelines do exist, e.g., Operations Manual for Quality Control and Assurance and Regulatory Monitoring of Wheat Flour Fortification Programs, Code of Practice for Food Premix Operations. Cori called for a global quality dialogue where all stakeholders could work together to raise the quality standard, establish consensual quality parameters, and convert existing guidelines into an adequate regulatory framework that will maximize the effectiveness of food fortification programs.

**DSM-WFP Partnership “Improving Nutrition – Improving Lives”**

Moderated by Klaus Kraemer, SIGHT AND LIFE, and introduced by Martin Bloem, Chief of Nutrition for WFP, this SIGHT AND LIFE-organized satellite session highlighted the partnership established between the UN World Food Programme (WFP) and DSM in 2007, dubbed *Improving Nutrition – Improving Lives*. Through this partnership, DSM provides technical and scientific expertise, nutrient-rich products as well as financial support to improve the nutritional value of WFP’s food assistance. Joint expertise is the key to successful development of new products. As part of the partnership, some of these products, such as Micronutrient Powders (MNP), are being used at large scale in a few WFP programs to learn lessons before a wider rollout to other WFP operations.

Presenting on evidence of the efficacy of MNPs, Stanley Zlotkin, of the Sprinkles Global Health Initiative, gave an overview of the importance of iron, the prevalence of iron deficiency, and public health interventions aimed at reducing micronutrient...
deficiencies. Dr Zlotkin highlighted Home Fortification and the development of multi-micronutrient Sprinkles™, and the results of efficacy trials of these that consistently found improved iron status, health, and appetite, and high acceptability among families and children across various cultures. To date, Sprinkles beneficiaries number over 2 million across 18 countries and Sprinkles home fortification interventions have led to 40–50% reductions in the prevalence of vitamin and mineral deficiencies.

Georg Steiger, of DSM’s Nutritional Improvement Program (NIP), presented on quality criteria for MNPs. MNPs are not new as a product category as they have been used for decades for industrial food fortification concepts and produced in bulk (for micronutrient blends for the food and pharmaceutical industry) in premix plants around the world. What is new, Steiger explained, is the market positioning of MNPs in the present context, in which the end consumer fortifies the food herself. This creates new challenges for the producer and requires additional quality criteria and measurements. These criteria include meeting consumers’ nutritional requirements, being accepted by consumers, safety, stability, storage, affordability, technical manageability, and legal requirements. The three areas for which criteria need to be set are ingredients, packaging, and the production process and facilities. Toward this end, the Home Fortification Technical Advisory Group (HFTAG) is developing a draft Guidebook on MNP quality.

Michael B Zimmermann, of ETH Zurich, presented on current and future research on the efficacy of MNPs and described the optimization and efficacy testing of low-iron MNP for complementary foods. In-home fortification of complementary foods with micronutrient powders can be effective, with low levels of iron fortification potentially being safer than high levels in high-risk areas for infection. However, low iron doses have little nutritional impact, unless their absorption is high. Dr Zimmermann described research to maximize iron absorption from a low-iron MNP with phytase for in-home fortification. Results of the iron absorption study indicated that optimization of the MNP led to 5-fold increase in iron absorption from a highly inhibitory meal, suggesting that this may allow for effective, untargeted in-home fortification of complementary foods with low levels of highly bioavailable iron. A double-blind randomized controlled trial in non-malarial areas in South Africa is currently being conducted among iron-deficient school-aged children to further verify efficacy.

Saskia de Pee, from WFP, presented on the use of MNPs in program settings, highlighting the experience thus far gained through the WFP/DSM partnership. With the aim of mainstreaming MNPs in its programs, WFP needs to learn lessons and assess impacts.
under program circumstances. MNPs have been used among 8,500 underfive children in refugee camps in Nepal; 101,000 underfives and 59,000 pregnant and lactating women in Bangladesh; and 55,000 refugees in Kenya. Vitalita Sprinkles (a type of MNP) distributed to internally displaced children aged 6–59 months in post-tsunami Aceh resulted in 25% lower risk of anemia among these children compared to their counterparts who had not received the MNP. The key issues to achieve effectiveness include program design and initiation, coverage and distribution, and acceptance, adherence and appropriate use of the MNP. WFP’s partnership with DSM has allowed it to gain traction with its Nutrition Improvement Strategy and develop an effective public-private partnership model.

Klaus Kraemer concluded the satellite session with his presentation on the lessons that have been learned from the DSM-WFP partnership. For this, Dr Kraemer focused on the experience of the partnership from the MNP program in Kakuma, Kenya, where there is a high rate of micronutrient malnutrition, particularly anemia, among the refugee population. In 2007, 86% of underfive children and 41% of women of reproductive age were anemic. The partnership between WFP and DSM led to a program that currently provides 55,000 individuals with a once-a-day MNP sachet for a period of one year. Dr Kraemer described the key challenges faced in establishing and implementing the Kakuma MNP Program, specifically in the areas of coordination, budgeting, formulation of the MNP, packaging, and communication – where shortfalls in planning and preparation resulted in delays that increased costs. Nonetheless, the lessons learned were not lost on the DSM-WFP partnership and the pitfalls encountered in the Kakuma MNP Program have led to better coordination, budgeting, formulation, packaging, communication planning and outcomes in other programs.

SIGHT AND LIFE released a series of briefs on the MNP programs in refugee and emergency settings as well as other materials on the WFP-DSM partnership, which were made available to attendees of the satellite session. Visit http://www.sightandlife.org to download these materials.

Editor’s note: Major plenary sessions of the Forum as well as the WFP-DSM partnership satellite meeting can be viewed as videocasts on the SIGHT AND LIFE website.
A Day in the Life of Werner Schultink

Werner Schultink is Associate Director, Nutrition section, Programme Division, UNICEF. In the latest of our series A Day in the Life, Werner talks with SIGHT AND LIFE about his role at UNICEF and the part that UNICEF plays in the global fight against micronutrient deficiency.

SIGHT AND LIFE (SAL): Werner, what does your job at UNICEF involve, and what are your key responsibilities?

Werner Schultink (WS): I’m in charge of the Nutrition section of the Programme Division at UNICEF headquarters in New York. My job involves advising on the overall global direction of UNICEF’s nutrition planning and liaising on UNICEF nutrition issues with other relevant UN agencies, NGOs and donor governments and agencies. I’m also responsible for the management of the Nutrition section, which comprises 16 professional staff. Tasks also include ensuring that our regional offices and selected country offices receive adequate support, helping with fund-raising and also reporting on nutrition programs.

SAL: A wide-ranging set of responsibilities! How long have you been in this position?

WS: About 2 years.

SAL: What took you into this role? Have you always been involved in the nutrition arena?

WS: My first degree was from the Agricultural University of Wageningen in the Netherlands, where I specialized in Human Nutrition. I followed this up with a PhD thesis at Wageningen entitled Seasonal changes in energy balance of rural Beninese women. These studies took me to West Africa. I then became an advisor on human nutrition to the GTZ, the German Agency for Technical Cooperation. This role took me to the University of Indonesia in Jakarta. In 1999 I became Senior Advisor Micronutrient Programs at UNICEF headquarters in New York. I then became Officer in charge of the Nutrition section at UNICEF HQ before moving on in 2003 to become Chief Nutrition and Child Development Officer at UNICEF’s India office in New Delhi. In 2007 I took up my current position. So yes, I have always been deeply involved in the nutrition arena. I’ve spent 17 or 18 years working in developing countries and the past two working here in New York.

SAL: What is the mandate of UNICEF’s Programme Division?

WS: The Programme Division guides UNICEF’s programming work. For example, we will provide guidance as to whether as an organization UNICEF should support the extensive use of Micronutrient Powder to improve complimentary feeding. The discussion of such a topic may well commence in one of our regional offices, but global policy will ultimately be set by the Programme Division here in New York.

SAL: You have dedicated your life to the subject of nutrition. Why is this topic so important to the world, in your view?

WS: I think the importance of nutrition has become abundantly clear in recent years. The Child Survival Series published in The Lancet some while ago positioned adequate breast feeding and complementary feeding as potentially the most influential factors on the
survival of children. Such publications put it in a nutshell: the importance of nutrition to the wellbeing of the world’s population is without question.

**SAL:** And what drew you personally to this field?

**WS:** I have always been interested by the way practical interventions can have a profound effect on public health. In the developing world today, many people have little or no choice as to where and how they live, and are not well informed as to what they can do to help foster their own health and that of their children via their diet. There are many people in the West with nutritional problems too, but information on how to tackle these problems is at least available in the West for those who are interested to learn more. In much of the developing world, the most basic information is not accessible. So helping to provide it to those who really need it has always been a great motivation for me.

**SAL:** Tell us a little about the UNICEF offices where you work, if you would, Werner.

**WS:** Well, I sit in a relatively small office in a rather sober-looking building. My colleagues and I in Nutrition are located right next to the Health team, and we work very closely together. UNICEF HQ is an extremely international environment. I have colleagues from all over the world, and this creates a very different atmosphere from that of a national ministry, for instance. Most people who work for UNICEF do so because they are passionate about what they do; it’s much more than just a way of earning a living for them. The working environment here is made all the more dynamic by the fact that we have a job rotation policy whereby people move on to a new position every three to five years. These positions may be here in HQ or else in the regions. So there is always an influx of new people with fresh ideas drawn from recent practical experience. This is very valuable, for it means that the people who work at HQ actually know what’s going on at country level – which is, for example, extremely helpful in a crisis, of course.

**SAL:** If you could change anything about your working life, what would that be?

**WS:** I must say I would like to have a better work-life balance, but a position such as mine is by its nature quite removed from people’s day-to-day lives. I do miss that direct intervention. But it’s in the nature of the role I perform here.

**SAL:** You mentioned at the outset a large number of organizations with which you are in regular contact. What does SIGHT AND LIFE mean to you in the context of the global fight against malnutrition?

**WS:** Work on micronutrient deficiencies, vitamin A supplementation, salt ionization and so on is fundamental to our programs, and SIGHT AND LIFE has an important role to play here. SIGHT AND LIFE creates a very effective bridge between scientific publications such as *The American Journal of Clinical Nutrition* and practical programs on the ground. It also helps create valuable links with the private sector.

**SAL:** Are there things that you dislike about your job?

**WS:** By and large I like my job very much. It’s very rewarding to know that your work can help make a difference to people in need. If there is an aspect I dislike, it’s that my job is by its nature quite removed from people’s day-to-day lives. I do miss that direct intervention. But it’s in the nature of the role I perform here.

**SAL:** What are the things that you enjoy most about your work?

**WS:** I think the most enjoyable thing about my work is seeing the way it can make a difference on the ground. It’s great to get feedback from around the world telling us that programmes are making good progress, that so and so many children have been provided with vitamin A or that breastfeeding rates in countries X, Y and Z are going up. These are the things that count the most for me.

**SAL:** And the magazine itself, Werner – are there parts of it that you particularly enjoy?

**WS:** As you can imagine, we receive an enormous number of journals, so I don’t read every issue of SIGHT AND LIFE Magazine cover to cover, but I look out for the articles on programming and also the summaries of major meetings. I find these very useful.
SA L: You mentioned that SIGHT AND LIFE has an important role to play in helping children with vitamin A deficiencies. What is the best way of reaching these children? How do you get through to the neediest sections of the populace?

WS: As is made clear by a new UNICEF report published this November, the use of child nutrition days and child health weeks is by far the most effective way of reaching the majority of children, especially in the least developed countries. This means organizing a special day or week when trained workers go around the local villages and spend a part of a day or even a whole day there, offering a package of services to all the mothers and children who should be targeted. Vitamin A is an important part of these services, but in many countries it’s now linked with other aid interventions such as de-worming, the provision of iron folic tablets to women or the dissemination of information on infant feeding and hygiene, for instance. It makes a big difference that these workers go out to the villages rather than simply sitting in a health center somewhere. The health center may just be too far removed from the mothers who most need its services, so going out in person is the best way to provide this essential support.

SA L: You mention mothers as a key target group. What is your view of the appropriateness of multiple micronutrient supplementation in the case of pregnant women?

WS: There’s a wealth of evidence to show that anemia is abundantly prevalent in all developing countries. Moreover, it is well documented that anemia is an indicator of a range of deficiencies, not just of iron deficiency. UNICEF explored the topic of multiple micronutrient supplementation 1999, taking as our cue the fact that the diet available to many people in the developing world is low in essential micronutrients. We recommended the use of micronutrient supplementation in pregnancy, and this led to a range of additional studies on the subject being published in the Food and Nutrition Bulletin. The Micronutrient Forum before last also presented overwhelming evidence that the use of these multi-micronutrient supplements had a positive impact on the micronutrient states of women and also resulted in a statistically significant improvement in birth weights. I therefore think that we should consider this approach very seriously.

SA L: Of course there are many bodies involved in the attempt to mitigate malnutrition, UNICEF being only one of them. How well do you think these bodies work together?

WS: Each of these initiatives has its own focus. Each tries to enhance the implementation of a multisectorial approach with a view to improving nutrition levels. Good planning between different agencies can make a significant impact, greatly enhancing the effectiveness of local interventions. I think it’s generally agreed that with a relatively limited simple set of interventions we can make a big difference if we all collaborate effectively. There is an enormous amount of collaboration and good communication going on at the moment, and a drive to all think in the same direction.

WS: I enjoy spending time with my family and I love to be out of doors. I do water sports in the summer, as well as biking and jogging. I also take pleasure in listening to a wide variety of music and in reading, but I always like to be outside when I can. We have a house in Canada where we try and spend a good amount of our leisure time.

SA L: Is there anything else that you’d like our readers to know about yourself and your work?

WS: I think this is a very good time to be working in the field of nutrition. There are so many exciting developments occurring at the moment, and I hope that many young academics will be attracted to the field. There is so much important work to be done!

SA L: Werner, let’s hope that your enthusiasm is passed on to the upcoming generation. Many thanks for taking the time to speak with SIGHT AND LIFE.

WS: Thank you.

Werner Schultink was interviewed by Jonathan Steffen.
Micronutrient Deficiencies and Affluence

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Deprivation, mortality and nutrition

In spite of the recent turbulence in the banking world and its effects on the economy of many countries, food availability and living standards in the industrialized countries of the west are vastly superior to the conditions of many people living in the developing countries of Africa and Asia and many other parts of the world. Furthermore most of us would agree that living standards have improved in those industrialized countries over the last century, yet nutritional problems still exist and a recent study of deprivation and mortality in the UK found no significant change in the strength of the relation between the start and end of the 20th century.1

The objective of the study was to examine the geographical relationship between mortality and deprivation in England and Wales at the start of the 20th and 21st centuries and explore the evidence for the strengthening or weakening of relationships over that time. The 20th century saw dramatic improvements in patterns of mortality. Age and sex specific mortality rates declined across all ages. Life expectancy has risen from 46 and 50 for men and women in the 1900s to 77 and 81 respectively in 2001. These changes are linked to major changes in the cause of death. Modern causes of death are dominated by cancer, ischemic heart disease and stroke. In the 1900s classification of mortality was less well organized; cancer and respiratory disease were important, but infectious and parasitic diseases accounted for nearly 20% of deaths.1

The definition of poverty has also changed over the century (Table 1). In the early 1900s, poverty meant the income of an individual was not “sufficient to obtain the minimum necessary for the maintenance of mere physical efficiency”. In fact this is the same meaning it still carries in many poor African countries today. However, in industrialized countries of the West, the 20th century has seen improvements in standard of living and the growth of the welfare state now means that poverty is defined as a relative state. Relative poverty is usually expressed by comparing the individual’s income or deprivation with that experienced by society as a whole but there is a well known, direct relationship between poverty and mortality even today.2

The causes of death in industrialized countries have changed over the century but in the UK there is a strong relationship between mortality levels a century ago and those of today. This is not surprising when you realize that the highest rates of deprivation and mortality in the 1900s were found in urban and industrial areas, with low rates mainly in rural areas. The positions of our cities have not changed; they have expanded and the areas with the lowest and highest 10th of mortality in the 1900s still have low and high mortality rates in 2001. Thus in spite of the changes in definitions and the fact that the mortality gap between the worst and the best has narrowed, there has been

<table>
<thead>
<tr>
<th>Year</th>
<th>Definition</th>
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<td>1901</td>
<td>The income of an individual was not sufficient to obtain the minimum necessary for the maintenance of mere physical efficiency.</td>
</tr>
<tr>
<td>2001</td>
<td>Income is now compared with that experienced by society as a whole and expressed as ‘relative poverty’.</td>
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little change in the geographic relationship over the century.\(^1\)

There is abundant evidence that poverty and deprivation are also linked to poor nutrition and health problems throughout the life cycle (Figure 1). The recent Lancet series on maternal, infant and young child nutrition drew attention to the importance of early nutrition interventions to improve child health and development and increase the chances for future economic productivity both for the individual and the community.\(^3\) Girls who are poorly nourished may fail to properly develop and this can impair fetal development when they too become mothers. Evidence suggests that poor fetal nutrition not only reduces the survival chances of the infant but may also lead to heart disease, diabetes and respiratory problems in later life. Poor nutrition leads to poor health which impairs working ability and the chance to prosper and the cycle is perpetuated. As indicated above however, deprivation is a relative term in industrialized and affluent countries in the 21st century, so what are the nutritional problems that maintain the link between deprivation and mortality?

**Changing lifestyles in the 20th century and nutrition**

The epidemic of overeating in North America and the United Kingdom together with sedentary lifestyles has led to a growing prevalence of obesity, diabetes and metabolic syndrome in children. It is not my intention in this article to discuss ways of tackling obesity but rather to discuss the way our changing food habits impinge on micronutrient nutrition. An excess of calories does not imply adequate nutrition and vitamin and mineral deficiency syndromes can still occur.\(^4\) Changing lifestyles, agricultural practices, food habits and food sources in modern society can also have an impact on micronutrient nutrition. Our intake of selenium in Europe has reduced markedly over the last 30 to 40 years as importation of North American wheat has been replaced by European and home grown varieties for bread making.\(^5,6\) We know that selenium has an essential role in thyroid metabolism, sperm motility, antioxidant functions and immune defenses and may lower the risk of certain important cancers.\(^6\) Iodine status is reported to be low to marginal in infants and pregnant women in parts of Europe and cow’s milk is an important source of dietary iodine in these people.\(^7-9\) Iodine in cow’s milk is influenced by the feed which it eats\(^10\) and on the use of iodine-containing teat dips to prevent infection in the udder.\(^11\) Alterations in dairy cow husbandry may alter the iodine content of consumer milk, and this may increase the risk of thyroid diseases in the population and affect mental development in infancy.\(^12\) An insufficiency of iodine causes an enlargement of the thyroid gland known as a goiter and was very common in many counties of England in the 18th century, particularly in Derbyshire, where it gave rise to the name “Derbyshire neck”.

![Figure 1: Interaction of obesity and poverty on health through the life cycle.](image-url)
Inflammation and obesity

Currently selenium and iodine insufficiency appear to be only of borderline significance in European countries whereas the alarming rise in obesity prevalence is a major concern. Studies on the socio-demographic and life-style factors associated with obesity have identified poverty as a major factor related to childhood,13 adolescent14,15 and general obesity.16 White adipose tissue is now recognized as a multifunctional organ and in addition to its central role of lipid storage it has a major endocrine function.17 Studies on both humans and animals demonstrate a close association between obesity and a state of low grade, chronic inflammation in which there is macrophage infiltration in adipose tissue and increased circulating concentrations of pro-inflammatory molecules including acute phase proteins, cytokines, adipokines and chemokines.18 In obese states these pro-inflammatory factors are produced predominantly from enlarged adipocytes and activated macrophages in adipose tissue and liver and can directly induce glucose intolerance and insulin resistance leading to diabetes and metabolic syndrome. It should be recognized however that these pro-inflammatory molecules are ‘alarm’ signals and that something triggers the adipocyte to promote the acute phase process.

What is the cause of the inflammation in obese people? It was suggested in 200417 that inflammation in adipose tissue in obesity was a response to hypoxia and more recently hypoxia has been demonstrated in the adipose tissue of several obese mouse models.19 In exercise, as well as cancer and ischemia, hypoxia is known to activate hundreds of genes vital for cell homeostasis and angiogenesis, including inflammation.20 The inflammatory response is intended as a rapid response to external or internal signals of danger but it should be of limited duration. The continuing hypoxia in overweight and obese people promotes a state of chronic inflammation to which the body attempts to adapt but in so doing can increase the risk of anemia,21–23 diabetes and metabolic syndrome.24

Iron deficiency and obesity

Anemia is one of the commonest clinical indicators of poor nutrition in industrialized countries and the prevalence of iron-deficiency is high particularly in overweight toddlers.23 A report in which secular trends in iron deficiency in children 1–3 years were examined in data from the US National Health and Nutrition Examination Surveys (NHANES) from 1976 to 2002 found little change in the prevalence over 22 years. In children described as poor, prevalence had declined to around 9% but in those who were overweight (weight for length in the 85th to 94th percentile) iron deficiency remained around 20–24%. The prevalence in non-poor households did not change (~7%) and multivariate analyses suggested that Hispanic, younger and overweight children had the higher odds of iron deficiency.23

Similar results were found in another study which examined data from overweight children 2–16 years from NHANES III (body mass index (BMI) in 85th to 94th percentile).21 These workers found that children who were at risk of overweight or who were already overweight were twice as likely to be iron deficient as those who were not overweight. To identify iron deficiency, the authors used the criteria of the NHANES laboratory, namely that iron deficiency existed if two of the following tests were abnormal: transferrin saturation, free erythrocyte protoporphyrin levels and serum ferritin levels. At least two of these measurements are changed by inflammation; serum iron and therefore transferrin saturation are depressed and
serum ferritin levels are elevated. Elevated ferritin concentrations can lead to under-reporting of iron deficiency, i.e. there may be even higher levels of iron deficiency in obesity.

Several workers have investigated the part played by inflammation in the disturbances in iron metabolism in obesity.22,24 Yanoff et al22 studied 172 apparently healthy non-obese and 234 obese (BMI > 30 kg/m²) adults (18–70 years). They found evidence of both inflammation (elevated C-reactive protein and ferritin concentrations) and iron deficiency (elevated transferrin receptor concentrations) and concluded that hypoferremia of obesity was due to chronic inflammation blocking the absorption of iron and eventually leading to iron deficiency.

As indicated above, obesity is considered to be a chronic inflammatory state25 and it is now known that inflammation up-regulates the production of hepcidin in the liver which disturbs the regulation of iron metabolism by blocking iron absorption and re-utilization. See SIGHT AND LIFE Magazine26 for description of mechanism. The main source of hepcidin in the body is the liver and expression of hepcidin by hepatocytes is more than 100-fold higher than that from adipocytes. However, in obese humans adipose tissue may be 20-fold greater than the liver mass so the combined production of hepcidin may have relevance to iron control in obesity. The other iron-regulating protein produced by adipocytes is lipocalin-2 and recent evidence suggests that white adipose tissue is a dominant site of its production.27 Adipose lipocalin-2 expression is increased by inflammatory cytokines interleukin-1 and tumor necrosis factor-2 and it is an important component of our innate immune system. It functions by competing with invading pathogens for bacterial iron.28 In humans lipocalin-2 is positively correlated with adiposity,18 and the increased amount in obese people may indicate that it is of pathological significance.

The other factor that might influence iron status in obese people is their large body mass. Iron requirements may be higher in obese than the non-obese people since two thirds of the body iron is found in the erythrocytes and blood volume is directly proportional to body mass.22 The anemia found in obese children21,23 therefore may be due to a combination of diminished iron absorption, impaired re-utilization and insufficient dietary iron.

The second study to examine the role of inflammation in obesity focused particularly on diabetes.24 The authors recruited 239 post-menopausal women with a BMI >30 kg/m² and with and without metabolic syndrome (MET; defined according the International Diabetes Federation guidelines27). The authors concluded that MET, and in particular type 2 diabetes, was the main contributor to the high ferritin levels found in obese people and that inflammation was an etiological factor.30 Other studies in apparently healthy populations have shown, however, that high ferritin concentrations independently predict the development of type 2 diabetes,31 that is, other factors associated with obesity are responsible for the high ferritin concentrations. High ferritin levels could indicate iron overload but liver autopsy studies in type 2 diabetics found iron levels no higher than those of non-diabetic patients.32 In other words, the study indicates that high ferritin concentrations in obesity are not responsible for the type 2 diabetes but that both may be the product of the chronic inflammation.

**Obesity and vitamin D status**

Body fat indexes have also been related to vitamin D deficiency in obese adolescents33 while other studies have reported the weight of adolescent girls to be correlated negatively with vitamin D.34 Unfortunately there is no universally accepted concentration of vitamin D (i.e. 25 hydroxy-vitamin D, 25-OHD) that defines deficiency. Workers from the Centers for Disease Control and Prevention who analyzed NHANES III data (1988–1994) reported vitamin D deficiency (< 17 nmol/L) was unlikely in the US population but that insufficiency of the vitamin (< 25 nmol/L) was fairly frequent in younger individuals and non-Hispanic blacks.35 Adequate vitamin D is essential for normal growth and vitamin D deficiency has been associated with a wide variety of illnesses and chronic conditions.33 According to NHANES surveys, 17.1% of children and adolescents were obese based on a BMI > 95th percentile and obesity in both sexes significantly increased over the period 1999 to 2004. The growing problem of obesity in children and the association with vitamin D deficiency is therefore of concern.

The study by Lenders et al33 of 58 obese adolescents was an attempt to investigate thoroughly the relation between body fat indexes and vitamin D status. These workers defined vitamin D deficiency as 25-OHD < 50 nmol/L and found 17 children were deficient. Also included in these studies were measurements of bone mineral density and parathyroid hormone (PTH). Elevated PTH would be expected in growing subjects and those with vitamin D deficien-
They found that PTH concentrations were normal suggesting that the children were neither vitamin D deficient nor growing. In addition bone mass was within national standards so there was no immediate concern that the low vitamin D status was affecting growth and mineralization of bone. The association between obesity and lower 25-OHD concentrations may have no functional consequences and merely indicate greater sequestration of the vitamin in the large amount of body fat.

There are concerns about vitamin D however because many people are solely dependent on UVB irradiation from sunlight for their supply. Northerly latitudes, long winters, clothing, climate and excessive use of sun-blockers compete with our efforts to meet vitamin D requirements. Mothers especially need sufficient vitamin D status to ensure the satisfactory status of their children. Low vitamin D status has been reported in pregnant women in America, Australia and the United Kingdom at latitudes where there is a marked seasonal variation in sunlight. During the winter season there may be no UVB irradiation and people rely principally on their stores because, where there is no supplementation policy, there is very little vitamin D in the diet. A study recently carried out in Northern Ireland looked at the effect of multivitamin supplement use on vitamin D status of pregnant (N = 99) and non-pregnant women (N = 38) through the winter and summer seasons. Vitamin D in the supplements ranged from 5 to 12.5 µg. Supplement users had significantly higher 25-OHD concentrations but it was notable that even in the supplement users during the winter and spring seasons, the majority of pregnant women had concentrations of 25-OHD < 50 nmol/L. In addition a risk of severe vitamin D deficiency (25-OHD < 12.5 nmol/L) was found in 1–2% of pregnant non-users during the winter months.

Sub-optimal vitamin D status in pregnancy may have significant consequences for the health of the child. There are suggestions that in utero or early life, vitamin D deficiency is associated with both skeletal and non-skeletal consequences including increased risk of schizophrenia, type 1 diabetes and asthma. It is reported that the worldwide prevalence of asthma and allergic diseases began to rise in the 1960s and it is suggested that as populations became more prosperous, there was less exposure to sunlight as more time was spent indoors and therefore less cutaneous vitamin D synthesis. To support their hypothesis, the authors reported that higher vitamin D intakes by pregnant mothers reduced the asthma risk of children 3–5 years old by 40%. It is certainly true that vitamin D status is strongly linked to daylight exposure. One study of people approaching retirement age found habits like dog-walking or using an allotment, or a holiday in a sunny country in the recent past, all favored high 25-OHD concentrations. Skin color is also reported to influence vitamin D status with lower 25-OHD concentrations being reported in African Americans. However, analyses of racial and income data from 14,244 American children under 18 years found poverty to be the more important factor in determining risk of asthma and that it was only in the very poor where non-Hispanic black children had a higher risk than non-Hispanic white children. Another study that examined risk factors for asthma in 9,243 adults 20–85 years from the 2001–2 and 2003–4 NHANES surveys found that extreme obesity and living in poverty were strongly associated with asthma in both men and women.

**Key messages**

- Poverty is self perpetuating.
- Poverty is associated with obesity.
- Obesity is a chronic inflammatory state and hypoxia in white adipose tissue may be the trigger for the inflammatory response in obese people.
- Obesity is associated with iron deficiency, high serum ferritin concentrations, poor vitamin D status.
- Iron deficiency and high serum ferritin concentrations may be a consequence of the chronic inflammatory state in obese people.
- Obesity and high serum ferritin concentrations are risk factors for diabetes and metabolic syndrome.
- Iron deficiency is associated with poor cognitive development which may impair economic productivity and, in conjunction with poor health, perpetuate poverty in later life.
- Poverty and obesity are strongly associated with asthma in children and adults and it has been suggested poor vitamin D status may be a contributory factor.
Conclusions

The association between poverty in urban areas and a higher risk of mortality is not a new phenomenon. Living conditions in industrialized countries have improved through the 20th century. We live longer lives and the abject poverty of the 1900s has been removed to a large extent by the welfare state in industrialized countries. Nutrition has both improved and deteriorated. We now consume an excess of calories and the resulting obesity is influencing the diseases that now end our lives. Some micronutrient deficiencies like iron and vitamin D still exist. Poor dietary intakes may contribute to these deficiencies but they are not just a product of poor food but more a product of poor lifestyle. Improving nutrition in the 21st century will require lifestyle changes.

References


IRC Border Eye Program

Summary of grantee accomplishments since August 2008:

- Eye clinics have been resourced and are functioning smoothly in each of the nine refugee camps along the Thai – Burma border and at the Mae Tao Clinic in Mae Sot;
- 52 health workers received training in basic refraction skills;
- Nearly 15,000 schoolchildren in the camps have undergone vision screening;
- 670 eye surgeries have been completed;
- More than 8,000 pairs of eyeglasses have been provided to adult patients.

Tackling avoidable blindness through partnerships

Approximately 1.4 million children worldwide are blind. In addition, nearly 17 million children with low vision or impaired sight lack visual aids, services or eyeglasses to help them function. As a component of A2Z: The USAID Micronutrient and Child Blindness Project, the A2Z Child Blindness Program uses competitive grants to reduce child blindness and improve eye health. Grants provide support to NGOs to deliver services to populations in need. The goals of the program are to:

- Expand delivery of high-impact direct services, including screening, treatment, education and rehabilitation;
- Scale-up innovative approaches to service provision and program implementation; and,
- Contribute to the global knowledge base on effective approaches to large-scale child eye health programs. Managed by the Academy for Educational Development (AED) since 2005, the A2Z Child Blindness Program has awarded 32 grants to 23 organizations working in 25 countries across Latin America, Asia, and sub-Saharan Africa. In 2008, a new grant award category – Refugee Service Delivery – was introduced to fund initiatives which deliver comprehensive eye care services for children and families in refugee populations. Given their long-standing experience working with vulnerable populations worldwide, the International Rescue Committee (IRC) received two grant awards in August 2008 to support their efforts in Thailand and Kenya. The following case study provides an in-depth look at IRC’s experience and impact along the border of Thailand and Burma.

The Border Eye Program: Restoring sight and expanding services

The IRC has provided assistance to Burmese refugees since 1990, though the Thailand program has been operating since 1976 (initially assisting other groups of refugees – Cambodia, Laos and Vietnam). Eye care services have been provided to this population since 1997 through the Border Eye Program. This is the only source of eye care services for the estimated 134,401 refugees that currently live in the nine camps along the border of Thailand and Burma.

Health care in camps is provided by various international agencies that train, equip and supervise refugee health workers who staff health outposts, clinics and inpatient departments. The Border Eye Program trains and equips refugee health workers to provide basic eye care, dispense simple eyeglasses, and facilitate cataract surgery so that the level of eye care is compatible with and integrated into the refugee health care system. The program also works with Karen Aid, a small private UK charity, to provide cataract and other eye surgery to this population.

An estimated 2 million Burmese migrants, both registered and undocumented, are living outside of refugee camps in Thailand, and more than 500,000 internally displaced persons (IDPs) are living in eastern Burma. The Border Eye Program reaches part of these populations by providing services through the
Mae Tao Clinic, which offers various medical, health education and social services to migrant workers residing in or around the Mae Sot area. The Clinic also attracts a number of IDPs and other patients from Burma, where access to health services is limited. Moreover, the program offers mobile eye care services to Thai villages close to the camps, conducting screenings and providing eyeglasses.

The main objective of the Border Eye Program is to restore sight by providing more than 10,000 eyeglasses annually, and facilitating 500 cataract surgeries each year.

**IRC’s approach: Capacity building to strengthen local services**

IRC’s Border Eye Program focuses on training refugee health workers in basic refraction skills to conduct examinations and provide ready-made eyeglasses in IRC-supported eye clinics located in each refugee camp and at the Mae Tao Clinic. The program coordinates its work with the NGOs and refugee health organizations responsible for health services in each camp. Eye clinics are open one to two days a week in the refugee camps, and every day in the Mae Tao Clinic. Patients attending eye clinics are often self-selected, or referred by health clinics if a surgical problem or refractive error is suspected.

One innovative element of the current program is the initiation of standardized vision screenings at schools in each camp. Health workers coordinate with camp administrators and schools to train a group of teachers to conduct the tests, with the aim of ensuring students in all 64 schools in the nine camps are screened over a two-year period. Schoolchildren who fail the screening are referred for further examination at the eye clinic and are provided eyeglasses as needed.

The program also provides eye surgery to cataract and other surgical candidates identified in the eye clinics. Candidates who are registered for possible eye surgery are prioritized according to the severity of their vision loss. IRC has a long-standing collaboration with Karen Aid, which now sends a team of eye surgeons to the border three to four times a year. IRC facilitates visits by providing logistical support and IRC-trained health workers from the eye clinics assist with pre-operative preparations, surgery, and post-operative follow-up. Health workers conduct next day, day four, and six week check-ups. The surgical team typically deals with cataract problems, but also treats patients with glaucoma and other conditions that may require surgery. Referrals outside the camp are arranged for congenital cataract cases (involving children).
Evolution of the program model

IRC has implemented the Border Eye Program since 1997, when camp-based eye clinics and the provision of primary eye care and basic refraction training for health workers were first introduced. Distribution of eyeglasses began in 1998, and between 1998 and 2001, eye clinics were established in each refugee camp. A working relationship was established between IRC and a surgical team from the UK, with medics trained to screen patients for eye surgery. At that time, an aim of the Border Eye Program was to address preventable forms of blindness, such as trachoma. The program helped to deliver a series of community health education messages for promoting improvement in sanitation and hygiene to control trachoma infection. The program also emphasized the importance of a nutritious diet in preventing vita-

IRC Border Eye Program

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min A deficiency. Incidence of trachoma infection and vitamin A deficiency were significantly reduced, and ongoing vitamin A duties have been handed over to the border-wide nutrition program.

Since 1999, the focus of the program has increasingly shifted towards restoring sight and further developing the work of eye clinics, including piloting the provision of services to children. Close collaboration with Karen Aid enables more frequent visits by the surgical team, increasing the surgical capacity of the program. The program also began to target rural Thai villages in collaboration with the Ministry of Public Health, dispensing eyeglasses for a small fee ($3 per pair). This effort contributes to increasing acceptance in the Thai community for the many Burmese migrants and refugees living amongst them.

Activities implemented under the A2Z/USAID grant reflect the continuation and expansion of the approach established during previous phases of the program. For example, funding has facilitated the introduction of school screenings in all refugee camps, enabling systematic identification of children with vision problems. The program’s aim of restoring sight through improving the quality of eye care via provision of eyeglasses and cataract surgery contributes to IRC Thailand’s objective of strengthening the quality of health care services available to displaced persons. Working in partnership with Mae Tao Clinic to service the eye care needs of Burmese IDPs aligns with a broader goal of ensuring partners provide effective, documented and well-coordinated health support to vulnerable populations from eastern Burma.

Program achievements

Since the commencement of the USAID-funded project in August 2008, IRC’s Border Eye Program has provided resources (diagnostic equipment, supplies and eyeglasses) for eye clinics in all nine

<table>
<thead>
<tr>
<th>Result</th>
<th>Total</th>
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<tbody>
<tr>
<td>Health workers trained in basic refraction skills</td>
<td>52</td>
</tr>
<tr>
<td>Schoolchildren screened</td>
<td>14,492</td>
</tr>
<tr>
<td>Schoolchildren referred for examination</td>
<td>724</td>
</tr>
<tr>
<td>Number of eyeglasses provided to schoolchildren</td>
<td>152</td>
</tr>
<tr>
<td>Eyeglasses provided to adult patients</td>
<td>8,375</td>
</tr>
<tr>
<td>Adults whose significant refractive error is corrected</td>
<td>1,033</td>
</tr>
<tr>
<td>Adults who have received cataract surgery</td>
<td>591</td>
</tr>
<tr>
<td>Adults who have received surgery for an eye condition other than cataract</td>
<td>79</td>
</tr>
</tbody>
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Dr Frank Green, an eye surgeon who has been visiting the Thai-Burma border region for almost 20 years, says “without the training the Border Eye Program provides to the many medics and clinics they run, there would be no system of detection of eye disease amenable to our surgical treatment.” Dr Green and the other surgeons use their annual leave to undertake the visits, lasting 1–3 weeks, with support and encouragement from family. He says “I regard this work as a great privilege and a blessing in my life.”

refugee camps and the Mae Tao clinic. It has screened 14,492 schoolchildren in two refugee camps, with 724 children referred for further examination, and 152 children provided eyeglasses. Overall, 8,375 eyeglasses have been provided to adult patients in the nine camps, the Mae Tao Clinic, and through a mobile eye clinic servicing Thai villages in border areas. 670 surgical operations have been completed during three visits from Karen Aid, comprising 204 patients across five refugee camps and 466 patients in the Mae Tao Clinic. The program has also trained an additional 52 health workers to work in the eye clinics.
The Border Eye Program was the first health program to collaborate with all health NGOs working in the Burmese refugee camps along the Thai-Burma border. This unique approach extended the reach of the program and increased awareness of the difficulties faced by those suffering from visual impairment.

Challenges, setbacks, and lessons learned

An imminent challenge faced by the Border Eye Program is that implementation of activities is occurring in the context of large-scale resettlement of Burmese refugees to third countries, such as the United States. A disproportionate number of refugees being resettled are skilled and experienced health workers. All camp-based programs face the risk of insufficient numbers of trained staff. This issue is particularly important for the Border Eye Program given the central role performed by eye clinic staff. According to a recent assessment of eye clinics in the nine camps along the Thailand-Burma border, a majority of medics plan to resettle or are currently going through the resettlement process. To address potential shortfalls, 52 health workers (including 41 camp-based staff), have received training through the Border Eye Program in recent months. This figure is more than double the number originally envisaged for the first year of activity.

Another notable challenge faced by the program has been bringing together camp-based staff for joint training in a single location. Generally, camp residents are not allowed to leave the camps, which means that individual training – a more time consuming and costly exercise – has to take place in each camp. Successful advocacy with the Thai government has enabled staff to overcome this challenge, and camp-based health workers from five different camps were recently granted permission to travel for group training in Mae La camp. The program also faces the challenge of accessing remote camps during extended rainy seasons, and depending on the political situation in Burma, the possibility of an increase in camp populations.

The Border Eye Program is experiencing an increasing demand for eye care services at the Mae Tao Clinic, where a cost recovery model is being piloted in selected paying cases. The increased technical capacity to provide the exact prescription needed requires an upgrade of the technical skills and equipment in the Clinic. In addition, achieving a sustainable approach for providing and selling eyeglasses to rural areas of Thailand near the border is necessary to enable the Ministry of Public Health to fully incorporate services into the health care system.

Way forward

As the Border Eye Program enters its second year of USAID funding, the program will continue to roll out school vision screenings in the remaining camps, and there will be further visits by the UK surgical team to refugee camps and the Mae Tao Clinic.

Long-term, local capacity will be further strengthened, with a camp-based medic currently going through the process of being trained in basic cataract surgery. It is expected that more local medics could be trained in the future. Nay Hser, the eye medic in charge at Mae La camp selected to receive the surgery training, says, “It is huge challenge in my life. I hope that after I complete this course I will be able to help people not just in the camp but also in Karen state, my homeland.”

Further, as ready-made eyeglasses do not fully correct vision in all cases, IRC is considering a range of options to provide astigmatic correction in the long term, including developing a local lens edging/fabrication center at Mae Tao Clinic.

Key informants expressed the desire for services to be expanded so that, for example, eye clinics in camps could be open on a daily basis, and extend the range of services offered. The program would like to expand to focus on blindness rehabilitation and related needs in the future.

For more information on the IRC’s work in Thailand please visit http://www.theirc.org/where/Thailand. For more information on A2Z: The USAID Micronutrient and Child Blindness Program, please visit us on the web at www.a2zproject.org or via email at childblindness@aed.org.
Almost 71% of readers find the SIGHT AND LIFE Magazine that you are currently reading very interesting and 85% read it to get useful information relevant to their work! Good news from our recent reader’s survey, which was undertaken to ensure that the Magazine remains relevant and adds value to those working in the fascinating field of micronutrients. The Magazine is one of the core activities of SIGHT AND LIFE and aims to disseminate, as widely as possible, the latest information on micronutrients: from scientific findings, to events, to who’s who and who is doing what. And just as the survey tells us what you think about the Magazine, it also tells us about you:

- Almost 60% have at least a Masters degree and are aged between 30 and 50 years. Yet some 14% have high school or college experience, which shows that the Magazine reaches a wide target audience and we need to meet a variety of needs (Figure 1);
- 42% are based in Africa and 35% in Asia;
- the majority work for non-governmental organizations (NGOs) (35%) and universities (28%) (Figure 2);
- 67% have been reading the Magazine for more than 3 years and almost half for more than 5 years;
- and not surprisingly the majority work in the field of nutrition (62%) and health (68%).

Despite great diversity amongst our readership, the Magazine manages to be relevant to the work of most of the respondents (84.7%) and is viewed as a valuable source of information to update knowledge for about two thirds of them. Some 45% use it in their teaching and almost 40% believe it assists them with networking (Figure 3).

Half the respondents state that the Magazine is the ‘most important’ or a ‘very important’ source of information for their work and 38% consider it their ‘preferred source’ of information. This might be because some 70% find the articles ‘very interesting’, feel that the focus is good and find the articles neither too long nor too short. However, just over 1 in 4 respondents, especially those working in the NGO, private and government sectors, state that the Magazine is too technical and in terms of content the greatest negative expressed is that it is too diverse and the articles are too long rather than too short. This again highlights the wide range of needs of our readers, but we will continue to strive to meet as many of them as possible.

Of interest is that the Magazine is the preferred source, if not the only source, of relevant information on micronutrients for many of our readers. One out of four readers from NGOs stated that the SIGHT AND LIFE Magazine was nearly their only source of information and this was also noted, although to a lesser extent, amongst governmental organizations and UN agencies.

For a large proportion of our readers, the Magazine also remains a useful bridge to keep up to date with SIGHT AND LIFE’s activities, especially...
amongst those working in NGOs, where 70% consider the Magazine as a source of information on programs supported by SIGHT AND LIFE.

Figure 4 gives an indication of how readers feel about the different sections of the Magazine and shows a particularly high interest in the scientific articles – 95% rating this section as being of high and medium interest – so not surprisingly almost half the respondents felt that the Magazine could include more scientific articles. The project reports and news sections were also highly rated and it is interesting to note that even when sections were not rated as being of ‘high interest’, the majority are certainly of ‘medium interest’, which confirms that readers value the Magazine covering more than just the science and highlighting the role it plays in keeping people up-to-date with the broader micronutrient field. The SIGHT AND LIFE Magazine is unique in offering the broadest range of topics and article types in the micronutrient field which undoubtedly adds to its appeal amongst our readers.

In addition to its interest, 59% felt that the content is objective and impartial while 34% stated that it was neither impartial nor biased. We assure you that impartiality is a key objective and we will always attempt to ensure it stays that way – if you feel we aren’t achieving this goal in any way or in any article, let us know by writing a letter to the editor.

We also received unanimous support for the Magazine remaining available in the printed version but also having it electronically on the website is appreciated. Eighty percent of readers expressed their interest in receiving email notification when the latest electronic edition is available and, as perhaps could have been expected, half of the readers in Europe and North America would be satisfied to just receive email notification when the latest edition of the Magazine is available on the website, and would read the Magazine online. This might assist us in managing costs, especially as although 42% stated that they would be prepared to pay for the Magazine, many of our readers state that they cannot afford to buy it and we wish to continue to offer it as a free resource for as long as we can, knowing its value to our readers, especially in the developing world – a fact highlighted in the survey.

Topics that are repeatedly named as being important to our readers are HIV/AIDS, immunity and infection, food based approaches and agriculture and food security, and there is interest expressed in the Magazine covering practical issues such as the application of new science and insights and lessons learnt from programs. It would seem that our readers also enjoy the visual and 66% of respondents would like more visual elements to accompany the articles and 52% requested more photographs. We also appreciated other suggestions that were made that included...
having a glossary of terms, providing abstracts or a summary highlighting the key findings/facts/concepts of the articles and giving advance notice of training courses and conferences – so watch this space! Just as the SIGHT AND LIFE Magazine has evolved over the years, we will continue to look at ways of increasing its value and take cognisance of the feedback of our readers.

Thank you to the over 1,000 readers who responded to the survey either online or by post - your views and feedback are much appreciated. We are always happy to hear from our readers and encourage your inputs to the publication, so feel free to write to us with opinion pieces, let us know about events being hosted in your part of the world or interesting research/projects and programs that you might be involved with. After all, the SIGHT AND LIFE Magazine belongs to our readers and we look forward to many more years of fulfilling our role as defined by Saskia de Pee of the World Food Programme: SIGHT AND LIFE’s role as a bridge between science and programs is almost unique, very valuable and much needed.

Did you know?

- For the more than 50% of readers who would like to also have the Magazine electronically, visit www.sightandlife.org as the SIGHT AND LIFE Magazine is available online together with many of our other resources.
- 85% of our readers share their copy of the SIGHT AND LIFE Magazine with others (half sharing it with 2-5 people and 33% sharing it with more than 10 people), so if you don’t already, why not pass your copy on when you have finished reading it!
- If you don’t want to pass your copy on, why not recommend the SIGHT AND LIFE Magazine to your colleagues (they can subscribe online), as that how 41% of our readers got to know about it...
Micronutrient Deficiencies in Women and Children: Latest Findings

Symposium held at the International Conference on Nutrition, Bangkok, Thailand, 4–9 October, 2009

Micronutrient deficiencies are a major, preventable public health nutrition problem in the developing world, affecting women of reproductive age and young children. Supplementation by a variety of means offers a practical, direct approach to prevention across all age groups.

At a plenary session of the 19th International Congress of Nutrition (ICN) held on 4–9 October, 2009, scientists researching micronutrient supplementation summarized and shared their research findings and experiences to date on the extent of the problem of micronutrient deficiencies around the world and the impact of micronutrient supplementation on the status and health of vulnerable population groups.

The session started with an introduction by the chair, Klaus Kraemer (Switzerland) who made reference to the Innocenti Process, which seeks to clarify the links between evidence and programs. Juan Pablo Pena-Rosas (Switzerland) then presented on the global magnitude of the most common vitamin and mineral deficiencies (vitamin A, iron, iodine, zinc, folate), as recently updated by the WHO. Dr Pena-Rosas also described the WHO’s efforts to upgrade and expand its Vitamin and Mineral Nutrition Information System.

Tommaso Cavalli-Sforza (Philippines) spoke next on the effectiveness of weekly iron/folate supplementation in reducing the prevalence of anemia in women of reproductive age, particularly before pregnancy and during first trimester, followed by Parul Christian (USA), who highlighted the impact of antenatal iron-foolic acid supplementation on pregnancy outcomes for both mothers and their offspring, in terms of immediate as well as long term benefits. Barrie Margetts (UK) presented on a meta-analysis that found supplementation of pregnant women with 1 RDA of multiple micronutrients (MMN) increases birth weight and substantially reduces low birth weight and small-for-gestational-age (SGA) births. There was an increased (23%), although not statistically significant risk of early neonatal mortality in women taking MMN, which requires further research.

Deanna Olney (USA) described a study that found a significant positive effect of multiple micronutrient supplementation on motor development among children as well as small but significant improvements in length, height, weight, and hemoglobin, serum zinc and serum retinol status, though the effect on morbidity was not clear.

Saskia de Pee (Italy) presented on the World Food Programme’s (WFP) experience in providing multi-micronutrient powder (MNP)
at scale to WFP beneficiaries, including children, pregnant and lactating women, and refugees, and how MNPs were found to reduce micronutrient deficiencies and improve the nutritional quality of complementary foods, especially where there is a low intake of animal-sourced and fortified foods, and where the prevalence of anaemia and stunting is high. Jacques Berger (France) described the results and experience of a school-based intervention in Viet Nam that found multi-micronutrient-fortified biscuits, providing 50 per cent of the daily recommended intake of iron, vitamin A, iodine, zinc and other essential micronutrients, reduced the prevalence of anaemia, significantly improved iron stores, and enhanced deworming.

Michael Dibley spoke on a study examining the effects of starting multiple micronutrient supplementation early in pregnancy, which found that there was a significant increase in birth weight when supplementation started earlier than 12 weeks for both iron/folic acid and multiple micronutrient supplementation compared to folic acid alone. Multi-micronutrient supplementation reduced SGA, while iron/folic acid reduced low birth weight and early preterm delivery (< 34 weeks). Only iron/folic acid significantly reduced early neonatal mortality.

Florentino Solon (Philippines) concluded the session sharing a developing country perspective appreciative of the global efforts to establish a rigorous evidence base to support appropriate national policies and programs. He highlighted four key issues of interest to policy makers: evidence of efficacy, context (applicability to local settings), priority (which intervention is more likely to have impact, which age group will benefit), and implementation mechanisms (how the government will fund it, who will deliver it). The Philippine Department of Health is currently revising the country’s micronutrient supplementation guidelines, based on the latest evidence, which Dr Solon said would be ready by the end of 2009.

On 26 October 2009, SIGHT AND LIFE and DSM along with seven other Life Sciences companies met over 90 students on the Natural Science Day in Zurich, Switzerland. Throughout the day 12 students explored the possibilities of fighting “hidden hunger” and presented their results to all participants (fellow students and company representatives) in the afternoon before enquiring about career opportunities at the stands of the participating companies.
Helen Keller International Received António Champalimaud Vision Award

In September 2009, Helen Keller International (HKI) received the prestigious António Champalimaud Vision Award from the Champalimaud Foundation, which is based in Lisbon. HKI was recognized for our achievements in preventing blindness in the developing world, particularly our efforts to find effective and sustainable means to combat vitamin A deficiency (VAD).

The Champalimaud Foundation, one of the largest global science foundations in the world, initiated the €1 million (US$1.4 million) Champalimaud Award in 2006. Since then, it has alternately been given for blindness prevention on the ground and scientific research. The Award has the support of WHO’s VISION 2020 initiative, and has been referred to as the “Nobel Prize for Vision” by the former President of India, A.P.J. Kalam.

Giving the award to HKI has the potential to bring much-needed attention to the world-wide problem of vitamin A deficiency. As those of us who work to prevent vitamin A deficiency know, while the problem is widespread, the solutions that exist are extremely cost-effective – we just need to get them into the hands of those who desperately need them.

Working with partners, HKI currently offers vitamin A supplementation in 13 African countries and 5 Asia-Pacific countries. Our work is focused on creating sustainable delivery systems that will reach more than 80% of targeted children. Last year, 41 million African children and 46 million Asian children benefitted from our programs.

The 2009 António Champalimaud Award is a tremendous honor for HKI, and we hope that this new attention will translate to even more children receiving sufficient vitamin A and living happy and productive lives.

Expert Panel Convened to Advance Unified Advocacy on Global Problem of Hidden Hunger

On the eve of the 2009 International Congress of Nutrition (ICN) in Bangkok on 5–9 October, 2009, SIGHT AND LIFE convened an expert consultation to advance a unified advocacy strategy for including essential micronutrients as part of commitments to alleviate global hunger in all its forms. The meeting sought to develop a shared framework for consistently communicating issues on micronutrient malnutrition, or hidden hunger, and start the process of mapping global hidden hunger, in advance of the next World Economic Forum in Davos, Switzerland, in January 2010.

Given this ambitious goal, SIGHT AND LIFE invited a panel of renowned experts in nutrition, public health, agriculture, development and related disciplines to offer their opinions, insights and other contributions. Participating on the panel were high-level scientists, academics and decision makers from a range of global institutions, including UN agencies, US government agencies, universities, and international NGOs.

The consultation has its roots in SIGHT AND LIFE’s efforts to develop an advocacy strategy to advance the
understanding of hidden hunger, specifically in light of declarations by world leaders at the recent G8 and G20 summits to commit resources toward global food security initiatives. SIGHT AND LIFE’s Klaus Kraemer cited growing attention in the lay media to the problem of hidden hunger and stressed the need to ensure consistent messages are communicated in order to maximize awareness-raising and reduce potential confusion on the issue.

The panel drafted a working definition of hidden hunger and discussed options for a hidden hunger global prevalence map. These would be valuable tools for advocacy around hidden hunger and visually depicting its impact. It was emphasized that the definition would specifically be used for advocacy purposes, hence, it needed to be broad and all-encompassing but simple enough to gain buy-in from a wide range of non-technical stakeholder groups. A more technical definition to guide specific programmatic actions would be developed at a later stage.

The global hidden hunger map was agreed to be an important tool for enhancing the current perception of hunger with a broader understanding of the impact and reach of hidden hunger, which affects people in both developing as well as industrialized countries. Yet, many challenges remain in the development of such a map, particularly in relation to data availability, data sources, indicators, cut-offs, risk groups, and overlapping data.

While the discussion was dominated by the technical issues surrounding an agreed definition of hidden hunger and left a number of issues open, an important conversation had nonetheless been initiated that will continue among the expert panel. Highlighting that advocacy is as important as the science, Klaus Kraemer underscored that, given the intensity of competition between ideas and messages in the scientific community, the challenge is to develop broad consensus and consistent messages that are endorsed and used by all organizations working towards the eradication of hidden hunger.

He concluded „Working together on advocacy, communications and science is the new horizon.“
Dear Sir,

We are pleased to inform you that the Project Agency for Initiatives Promoting Sustainable Development (APRIDD) has successfully completed its distribution of vitamin A capsules (VACs) donated by SIGHT AND LIFE.

The distribution activities went very smoothly and according to plan. However, the demand for VACs by our partner health centers exceeded the quantity available. We followed the example presented in your DVDs carefully and are trying to imitate the program and the activities of Nutrimad in order to improve the nutrition of children in northern and southern Benin. To better meet the needs of children aged 0–5 years and promote a balanced diet, we have launched a campaign for the production and processing of local agricultural products (maize, groundnuts, soybeans, rice, etc.) with the support of a partner, SEL France, which has allowed us to build mills and workshops to process agricultural products.

Considering the importance of our activities and program, we hope to be recognized among SIGHT AND LIFE’s partner organizations that are active in the fight against malnutrition. Some of our work to combat malnutrition, currently on hold, can continue to be implemented through further partnership with and support by SIGHT AND LIFE.

Communicated by:
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Registration of the children receiving one vitamin A capsule
**Carotenoids Volume 5: Nutrition and Health**


This final volume of the Carotenoids book series— which details the fundamental chemistry of carotenoids, basic methods used in its research, and critical discussions of its biochemistry, functions, and applications—focuses on carotenoids in human health and nutrition.

The era of ‘functional foods’ began with the identification of chemical components of foods as important micronutrients. Carotenoids have featured highly among such micronutrients. Volume 5 traces the carotenoid story from food to biological actions, following on from the foundation provided in its companion Volume 4 on the fundamental properties of carotenoids. Other volumes in the series also provide key information relevant to studies of biological functions and actions.

Volume 5 consists of three parts. Part 1, on nutrition, covers carotenoids as dietary sources and supplements as well as their bioavailability. Part 2 discusses the actions of carotenoids and practical approaches that are beneficial to human health, like epidemiology and intervention trials, *in vitro* studies, and studies of anti-oxidant and pro-oxidant effects. Part 3 describes the protective effects of carotenoids against diseases, like cancer, coronary heart disease, and eye and skin diseases, and effects on the immune system.

Written for a target audience of researchers, clinicians, scientific libraries, food industry, biotech industry and pharmaceutical industry, *Carotenoids Volume 5* is a coordinated, integrated treatment providing up-to-date and critical research surveys by leading authorities in the field, and incorporating some background material to help make the chapters accessible to non-specialist readers.

For more information, please visit the website of the publisher, http://www.springer.com/chemistry/book/978-3-7643-7500-3.

**Nutrition: A Lifespan Approach**


Nutrition has arisen from many older established disciplines to become an active entity in its own right and is now rightly at the forefront of modern understanding of health and disease. Interest in nutrition has increased exponentially since the early 1990s and it is now recognized as a key element in the training of all health professionals.

One of the main challenges for the modern nutritionist is to translate complex scientific concepts into simple advice about food and health that can be understood by the lay public. Nutrition textbooks have traditionally divided human nutrition into basic science, public health and clinical nutrition; however, in *Nutrition: A Lifespan Approach*, Simon Langley-Evans spans these divisions, bringing together the full
range of disciplines into one accessible book through the lifespan approach. Taking the reader through how the body’s demand for nutrients continues to change across the many stages of life, such an approach allows full consideration of how diet relates to health, well-being and disease and provides an excellent vehicle to illustrate the key concepts in nutrition science.

_Nutrition: A Lifespan Approach_ is an important resource for undergraduate students of nutrition as well as those studying or working in areas such as human biology, health studies and sports science, where an understanding of human nutrition is required.

For more information and additional resources, please visit the book’s website, http://www.wiley.com/go/langleyevans.

**Introduction to Human Nutrition, Second Edition**


The Nutrition Society Textbook Series started 10 years ago as an ambitious project to provide undergraduate and graduate students with a comprehensive suite of textbooks to meet their needs in terms of reference material for their studies.

This textbook is designed to provide an introduction to human nutrition for students and professionals in related disciplines. Those who go on to study human nutrition will also be introduced to the many areas of diet and health that can be studied in greater depth in other Nutrition Society series textbooks. Besides the basic biology, readers are introduced to the concept of food policy and to the dual challenges to the global food supply, i.e., over- and under-nutrition.

The study of human nutrition at universities across the globe is rapidly expanding as the role of diet in health becomes more evident. This second edition of the book has been revised and updated to meet the needs of the contemporary student. _Introduction to Human Nutrition_ is an essential resource for students of nutrition and dietetics, and also for those students who major in other subjects that have a nutrition component, such as food science, medicine, pharmacy and nursing. Professionals in nutrition, dietetics, food science, medicine, health sciences and many related areas will also find much of great value within its covers.

For more information, please visit the Nutrition Society’s website, http://www.nutrition society.org, or the publisher’s website, http://as.wiley.com.

**Nutrition Through the Life Cycle, Third Edition**


One of the most respected nutrition life cycle texts in the higher education market, _Nutrition Through the Life Cycle_, Third Edition uses current research to explain the nutritional foundations necessary for the growth, development, and normal functioning of individuals in each stage of the life span. From preconception to the final stages of life, this text covers clinical and nutritional interventions for each part of the life cycle.

The book is organized systematically, with clinical nutrition topics following normal nutrition topics. It maintains a consistent level of pedagogy throughout, highlighting key nutrition concepts, nutritional needs,
nutrition and health disease outcomes, model programs, and case studies.

Knowledge about nutrition and health through the life cycle is advancing remarkably. New research is taking our understanding of the roles played by nutrients, nutrient-gene interactions, body fat, physical activity, and dietary supplements to new levels. Recommendations for dietary and nutrient supplement intake and for physical activity in health and disease are changing due to new insights.

This third edition of the book incorporates emerging areas and updated information of direct relevance to nutrition. Additionally, this edition highlights key points at the end of each chapter; it includes ‘In Focus’ boxes that provide background information on the major conditions and disorders addressed in the various chapters throughout the book; provides additional case studies, tables, illustrations, margin definitions, and headings have been added to chapters; and lists updated Web and other resources, including interactive and streaming media sites, and newly developed nutrition education and information sites.

For more information, please visit the publisher’s website, http://www.cengage.com.

Community Nutrition in Action: An Entrepreneurial Approach, Fifth Edition


With the idea of social innovation becoming increasingly important in nutrition and development efforts, Community Nutrition in Action: An Entrepreneurial Approach, Fifth Edition provides an important resource to professionals, researchers and students in this field. This textbook introduces the program planning, policies, resources, and nutrition issues specific to community nutrition and provides an understanding of the development and implementation of nutrition programs among various constituencies (e.g., elderly populations, children, impoverished populations, college students).

Successful practitioners in community nutrition have proven to have a mind and skill set that opens them up to new ideas and ventures. Incorporating an entrepreneurial approach, this book helps readers learn how to take risks, try new technologies, and use fresh approaches to improving the public’s nutrition and health status. The book also delivers the core material important to those who will be active in solving community nutritional and health problems, including program delivery, nutrition education, nutrition assessment, and planning nutrition interventions.

The book is organized into three sections. Section One shows the community nutritionist in action within the community. Section Two describes current US federal and non-governmental programs designed to meet the food and nutritional needs of vulnerable populations. Section Three focuses on the tools used by community nutritionists to address nutritional and health problems in their communities.

For more information, please visit the publisher’s website, http://www.cengage.com/wadsworth.

Community Nutrition: A Handbook for Health and Development Workers


Written in an easy to read style and generously illustrated, Community Nutrition: A Handbook for Health and Development Workers was written for health and other development professionals working at community and district levels as well as for teachers and students of nutrition. It provides accurate, reliable and relevant information based on established international guidelines.

Covering the basics, such as nutrients and foods, feeding the family, and the causes, diagnosis and control of malnutrition through the life cycle, the book delivers insights on undernutrition and micronutrient deficiencies. In particular, it brings
attention to the emerging challenge of chronic conditions (such as diabetes, obesity, hypertension and cardiovascular diseases) and to the links between nutrition and HIV.

The book not only delivers on theory and science, it also gives guidelines on program implementation and changing behavior through better communication. There are appendices on energy and nutrient needs, sources of nutrients, food composition tables and anthropometric measurements as well as a list of recent materials and other sources of information.

The book is available from:

• Teaching-aids At Low Cost (TALC) www.talcuk.org and info@talcuk.org price UK£5.50 plus distribution costs;
• African Medical and Research Foundation (AMREF) bookshop, PO Box 30125-00100, Nairobi, Kenya http://www.amref.org/info-centre and info@amref.org;
• Macmillan Education, Between Towns Road, Oxford OX4 3PP, UK e.wilson@macmillan.com and through good bookshops.

NEW + NEW + NEW + NEW + NEW + NEW

Special Supplement

Impact of climate change, the economic crisis and the increase in food prices on malnutrition

It cannot be ignored; the global food supply system is facing serious new challenges as a result of both the economic and related crises and climate change. These directly affect the nutritional well-being of the poor, by reducing their nutrition security together with their food security. Diet quality and eventually diet quantity decline and this exacerbates the vulnerability of the already vulnerable, who find themselves fast-tracked along the downward spiral of malnutrition and poverty. These shocks lead to nutrition insults that have the greatest impact on infants and children – negative effects that persist into their adult life. So while the crisis itself might appear to be relatively short lived, the effects last through generations.

Following a meeting hosted by SIGHT AND LIFE at Castel Gandolfo, Italy, in early 2009, a set of 17 papers will form a supplement entitled, ‘Impact of climate change, the economic crisis and the increase in food prices on malnutrition’, in the January edition of the Journal of Nutrition, but are already available on the ‘Articles in press’ section of the journal website http://jn.nutrition.org/

This unique supplement, the first to address the impact of the triple crisis on malnutrition, covers an extensive range of topics from the importance of safety nets and the need for nutrition surveillance systems, to the impact on child mortality and the role of complementary food supplements. The series includes an editorial comment by David Nabarro, Special Representative of the United Nations on Food Security and Nutrition.

So while the world continues to focus its attention on the direct environmental effects of climate change and the pain of the economic recession continues to be felt, the 2 billion suffering from micronutrient malnutrition (hidden hunger) remain largely neglected and yet their plight is likely to have the most devastating long term effect. The time for action and the up-scaling of programs is NOW.
Photo credits: Janice Carr, Content Providers(s): CDC/ Dr. Patricia Fields, Dr. Collette Fitzgerald, page 16, 17 Martin Malungu, page 31

Colophon

SIGHT AND LIFE Magazine
Incorporating the Xerophthalmia Club Bulletin

Publisher: SIGHT AND LIFE
Editor: Klaus Kraemer
Editorial team: Jee Rah, Anne-Catherine Frey, Svenia Sayer-Ruehmann,

Communication consultancy and text writing: Frederico Graciano, Jonathan Steffen

Layout and graphics: GAS - graphic art studio, Grenzach-Wyhlen
Printer: Burger Druck, Waldkirch
Language services: transparent, Berlin

Opinions, compilations and figures contained in the signed articles do not necessarily represent the point of view of SIGHT AND LIFE and are solely the responsibility of the authors.

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SIGHT AND LIFE is a humanitarian initiative of DSM