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The promise of a community-based approach to managing severe malnutrition: A case study from Ethiopia

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Abstract

Background. *Community-based therapeutic care (CTC) is a new strategy in the arsenal of techniques to manage complex nutritional emergencies in rural communities. The CTC approach uses a newly developed ready-to-use therapeutic food, Plumpynut, to rehabilitate severely malnourished children in their home communities. Emerging literature has suggested the CTC strategy yielded results that were superior to those of programs limited to therapeutic feeding centers, as measured by rates of coverage and numbers of children rehabilitated.*

Objective. *To compare the effectiveness of the CTC strategy in combination with conventional treatments for acute malnutrition. The expectation was that this program would support the growing consensus on the effectiveness of CTC strategies.*

Methods. *Data from monitoring the initial phase of program implementation were reviewed to ascertain program impact. The number of children participating and the outcome of their participation were assessed.*

Results. *Families became key participants in the rehabilitation of their children, and communities became strengthened through the mobilization of local networks and the improved knowledge base of local health workers. Recovery rates were comparable with international standards, and coverage far exceeded that of traditional center-based care.*

Conclusions. *CTC is an important tool to effectively address nutritional emergencies and may be a valuable entry point for long-term development, since it fosters capacity building and improvement in local communities. CTC programs may eventually be viewed as the entry point for more sustained development-oriented interventions, thus helping make the transition from relief to development.*

Key words: Africa, food aid, nutrition emergency, nutrition rehabilitation, participatory development

Introduction

For several decades, professionals in economic development have debated how to meaningfully empower local people to be participants in development in their own communities, and they have discussed how to engender sustainable development in rural communities. At the same time, there has been a debate as to how to make a bridge from food-aid relief to development activities so that the underlying causes of food shortage are addressed with the hope of preventing future food crises. One possible answer to all of these questions might be the wider implementation of community-based therapeutic care (CTC), since the approach is contingent upon high levels of community involvement and mobilization. CTC has been recently implemented in several contexts of food crisis where severe malnutrition is widespread and where nongovernmental organizations were attempting to achieve the greatest program coverage while minimizing dependency. This paper reports on one such program administered in southern Ethiopia by Save the Children USA. The premise of the CTC approach is that local people can become partners in

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Deconinck and Degefie were part of the Save the Children USA team that implemented the community-based therapeutic program in Sidama; Chaiken later participated as a consultant to monitor implementation. Deconinck and Degefie's roles were part of the program activities approved by the Ethiopian Ministry of Health, and Chaiken's work was approved by the Institutional Review Board for the Protection of Human Subjects at her home institution, Indiana University of Pennsylvania.

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the management even of severe nutrition emergencies and can be primarily responsible for the nutritional surveillance activities that accompany these programs. With a CTC approach, severely malnourished children are monitored and treated at home, with trained community volunteers helping to ensure that parents have the knowledge and resources to successfully rehabilitate their children. The effectiveness of CTC programs is a consequence of local capacity building, timely and sufficient delivery of supplies, and coordinated efforts between nongovernmental organizations and local and national governments.

The challenge of pervasive malnutrition

For many years, professionals in the field of child health have known that malnutrition is an underlying factor contributing to child mortality in developing countries, both by directly causing death and, more importantly, by exacerbating other health problems. Beginning four decades ago, Scrimshaw and his colleagues [1, 2] began describing the ways in which malnutrition has a synergistic relationship with infection: children who are malnourished are more susceptible to infections, and the infections exacerbate poor nutritional status. Pelletier [3, 4] supplemented our understanding by describing the "potentiating" effects of malnutrition on health problems, and recently the global impacts of this negative feedback loop have been quantified. Black et al. [5], in an article provocatively titled "Where and why are 10 million children dying every year," documented the most common variables associated with preventable child deaths; although they note that the specific causes are highly variable from country to country, undernutrition is a leading variable globally. They report that the greatest proportion of preventable child deaths occurs in sub-Saharan Africa and that "underweight status…and micronutrient deficiencies also cause decreases in immune and non-immune host defenses, and should be classified as underlying causes of death if followed by infectious diseases that are the terminal associated causes…. Relative risks for mortality in children younger than 5 years derived from the ten studies assessed have been used to estimate that 53% of all child deaths could be attributed to being underweight." This relationship among undernutrition, child mortality, and infection is not surprising and has been documented by anthropologists to be part of the knowledge of indigenous people; for example, the Himba people note that "hunger does not kill, it is sickness that kills" [6].

Within the context of Ethiopia, the problems of food insecurity and subsequent child undernutrition are chronic and well documented. Ethiopia has been prominent in the work of both donors and nongovernmental organizations that target hunger, as well as in the world press, as epitomizing the challenge of repeated and pervasive food insecurity and famine [7, 8]. In attempting to address this chronic problem, Marchione and Novick [9] have called for donors to focus on building greater capacity, resilience, and food production in Ethiopia to reduce vulnerability to food shortage and subsequent dependence on relief aid. They recommend that employment-generating schemes such as food-for-work and cash-for-work programs be greatly expanded to improve public works and infrastructure, not only to provide greater food security during vulnerable periods, but also to improve the access of rural people to adequate sanitation, transportation, and markets and to improve agricultural systems and stabilize ecosystems [9]. Within the context of Ethiopia's patterns of famine and food aid, Marchione and Novick acknowledge that the emphasis on short-term emergency assistance (which has characterized most aid to Ethiopia) must be shifted to address the root causes of food insecurity in order to establish a safety net for vulnerable rural people. This proposed policy and program shift may be most feasibly accomplished through more widespread implementation of a CTC approach, since CTC programs promote community understanding and participation and facilitate a shift from an emphasis on relief to an emphasis on integrated rural development.

At the same time as this macro-level philosophical debate has continued, a more pragmatic debate has been carried on about the most effective means to ameliorate food emergencies. Previous critiques have focused on problems with timely delivery of aid, the effects of food aid on local economies and production, and the alteration of gender roles, migration, and household resource allocation that can result from food aid programs [6, 7]. Chambers [10, 11] and Sen [12] have called for greater community participation in development planning, noting the failures of programs that have neglected grassroots realities. These broad theoretical issues are relevant when specific strategies to effectively address the needs of hungry children and their families are being examined.

Methods

Strategies to implement CTC

CTC is a recent innovation designed to treat severely malnourished children while having less disruptive effects on their families and household economies than the more traditional approaches that emphasize treatment in hospital-based nutrition rehabilitation units or therapeutic feeding centers. The CTC approach has been implemented only recently, and the published literature on this approach is limited. The basic premise of CTC is that with allocations of therapeutic foods, appropriate medical care and clinical monitoring, and

educational support from community-based volunteers, the majority of severely malnourished children can be rehabilitated while remaining at home with the parents managing the care and feeding of the affected child. The approach is predicated on the assumption that building on community social and governmental structures is the key to rapid, effective mobilization, and that this strategy can ensure greater coverage and timeliness for delivery of nutrition rehabilitation. The severely malnourished children receive a daily ration of 200 kcal per kilogram of body weight of the ready-to-use therapeutic food Plumpynut, which was developed in France by Nutriset [13]. This food represents an important technological advance in the treatment of severely malnourished children, as it provides a nutritious, easily metabolized, energy-dense food that is shelf stable and resistant to contamination. One packet of this product contains 500 kcal in only 92 g of Plumpynut, and it is well tolerated by children, who like the taste. It contains the full complement of micronutrients necessary for rehabilitation of severe malnutrition and is nutritionally equivalent to the therapeutic milk-based F100 formula used in nutrition rehabilitation units and therapeutic feeding centers, but it has the advantage that it requires no mixing and is therefore less prone to bacterial contamination than milk-based formulas. Currently the greatest limitations of Plumpynut as a ready-to-use therapeutic food are its cost and the fact that it must be imported, but local production with local ingredients has begun elsewhere in Africa (Malawi, Niger, and the Democratic Republic of the Congo), and recently (January 2005) in Ethiopia.

The participating children also receive supplemental food rations that typically include a fortified flour, corn-soya blend (CSB), that is premixed with cooking oil and sugar. In order to minimize the sharing of food intended for the sickest child, and in acknowledgment of the fact that if there is one severely malnourished child in a household, the other children are likely also to be at increased risk of malnutrition, the supplemental ration is intended to satisfy a portion of the caloric needs of the other children in the family, not just the affected child or children.

One of the first experiences with the CTC approach was in Malawi, where the CTC program was able to cover 73.9% of the affected population, as compared with only 26.3% reached by the conventional inpatient approach [14, 15]. In comparing recent CTC programs in Afghanistan, Sudan, and Ethiopia, Taylor et al. [14, 16] reported that the programs had marked success, with mortality rates ranging from 1% to 8.6%, default rates generally below 10%, and 60% to 81% of children reported as recovering after participation in the program.

The first major published account of CTC programs was Collins and Sadler's [17] retrospective cohort study of 170 children who participated in a CTC program in Ethiopia. The authors report that 85% of children with severe malnutrition recovered, with 4% mortality, 5% defaulting from the program, and 6% referred to a medical facility—all of which are impressive records of success, and significantly better than the international Sphere Project minimum standards [18]. Overall experience suggests that children in the CTC program gain weight somewhat more slowly and require a longer period of participation than children cared for as inpatients but are at less risk of cross-infection from other sick children and are less likely to be removed from the program by their parents. Given the small but growing body of literature documenting the success of the CTC approach, it is time to scale up this approach for broader application in nutrition emergencies.

Impetus for CTC implementation in the Southern Nations and Nationalities Peoples Regional State, Ethiopia

In 2003, the lowlands of the Southern Nations and Nationalities Peoples Regional State (SNNPR) in south-central Ethiopia, especially the Sidama Zone, were hit by a significant drought, despite the fact that this is an area not usually associated with the drought cycles for which Ethiopia is known. Although the drought was certainly a factor that contributed to the food insecurity that this area experienced, the problems arose as a combination of factors that resulted in these poor communities facing true famine for the first time in many years. The local farmers traditionally grow a combination of crops: maize and *ensete* (*Ensete scitamineae,* or false banana) as their staple foods; *khat* (*Catha edulis,* a mild stimulant common in the region), coffee, eucalyptus, and fruit as cash crops; and some vegetables for home consumption. Agronomists argue that ensete has several ecological advantages over cereal grains: the leaves and plant debris rot around the base of the tree, providing a natural mulch; it is beneficial as a shade and windbreak for other plants (especially coffee); and it can be cultivated on slopes to stabilize hillsides and minimize erosion [14, 19]. However, it is far less nutritious than the staple grains that are the major foods elsewhere in the country and thus is not favored by nutritionists.

Landholdings are fragmented and very small per capita, due in part to rapid population growth in this area, and even in the best of years production is not adequate to fully meet the families' needs for the year. Most families must find additional sources of income to tide them over between harvests; local people engage in activities such as basket making, collecting firewood and producing charcoal, chiseling bricks, crushing stone to sell as gravel, and sifting soil to create piles of sand to sell as construction materials. In 2003, the lowlands faced a crisis when drought caused a nearly total failure

of the maize crop and poor production of ensete and vegetables, and the global price for coffee plummeted, resulting in their receiving minimal income for their coffee. With a loss of most of their subsistence base and a cash income from coffee that did not cover their production costs, most families went from a precarious existence to total food insecurity.

The emergence of the problems was identified through a regional early warning system of the Disaster Prevention and Preparedness Commission (DPPC), which then consulted with several donors. The DPPC identified the *woredas* (districts) that were most affected and enlisted the assistance of donors and aid organizations to address this crisis. Coordination meetings began in May 2003 to ascertain the best course of action and to identify which nongovernmental organization would serve in each area, to avoid replication of services, ensure more uniform and effective coverage, and optimize the effectiveness of service delivery.

Save the Children USA implemented programs that provided emergency nutrition intervention and support services in health, water, and sanitation to three adjacent woredas within the SNNPR. The districts were several hours away from the regional capital of Awasa by a four-wheel drive vehicle and equally distant from a referral hospital. Each woreda is composed of approximately 20 smaller administrative units called *kebeles* (subdistricts), each of which in turn is composed of five to seven villages of several thousand people each. Relief efforts in this area are complicated by the poor infrastructure of the region: the roads are rough dirt, electricity is limited to a few areas, and health clinics and hospitals are underequipped, understaffed, widely dispersed, and serve large populations. The local population is sizeable; indeed, population pressure is very high and is clearly one of the root causes of the resource inadequacy of the region. Water and sanitation facilities range from poor to nonexistent, and about 80% of the people obtain their drinking water from unprotected springs and streams that are easily polluted by humans and animals.

Implementation of CTC

The initiation of efforts to provide health and nutrition interventions by Save the Children USA started with the opening of 16 therapeutic feeding centers, which were intended to rehabilitate children with severe malnutrition. These children were identified by a weight-for-height ratio less than 70% of the median for a reference population, bilateral pitting edema (severe fluid retention in the feet and extremities that is indicative of kwashiorkor), or a mid-upper-arm circumference (MUAC) less than 11.0 cm (indicative of marasmus and increased risk of mortality). The first therapeutic feeding centers were staffed largely by Ministry of Health staff, supplemented by Save the Children USA staff. The facilities were often rudimentary tent structures adjacent to existing health centers and were intended to bring critical services to communities that were distant from hospitals. The therapeutic feeding centers were under stress from the outset, since the caseload was very high and the facilities, especially the supply of safe water and sanitation, were not adequate.

In a therapeutic feeding center, the World Health Organization (WHO) protocol for the management of severe malnutrition is to provide a basic medical package to treat infection and to use therapeutic milk-based formulas for nutritional rehabilitation. These milk-based formulas, F75 and F100, developed by Nutriset in France, were used for severely malnourished children because they are easily metabolized. Because these formulas are prepared by trained staff, there is little difficulty in maintaining the proper proportions of formula to water, and there is little likelihood of using unsafe water to mix the formula.

Although therapeutic feeding centers have the advantages of intensive 24-hour care and the availability of trained staff and medical services, they are not without their drawbacks. The problems are due not to the quality of the care they provide, but rather to the nature of the communities they serve. A typical length of stay in a therapeutic feeding center is three to four weeks, and the child must be accompanied full-time by an adult caregiver. This typically means that one parent is away from home for several weeks. The siblings of the child receiving treatment often suffer because they lack the care that they would normally receive, and the income that might be generated by the caregiving parent is lost during this period. If the period of a child's residence in a therapeutic feeding center or nutrition rehabilitation unit coincides with the agricultural cycle, the impact is even more severe because the parent is unable to perform the critical work of planting, weeding, and tending a farm, and the resulting drop in food production increases the risk of food insecurity in the following year. Families typically perceive a stay in a therapeutic feeding center as a significant hardship, and defaulting from the program is common when parents feel compelled to return home. Another problem is that residence in a therapeutic feeding center increases the risk of cross-infection resulting from the crowding of many sick children in a limited space. Children risk exposure to other illnesses that can complicate their recovery and rehabilitation. Because therapeutic feeding centers are fairly complex and expensive to staff and run and are often a long distance from the households of affected children, they typically provide care to only a small proportion of the children who would potentially qualify for such services.

Because of the gravity of the problems, the increased need for nutritional response in the region, and the emerging literature suggesting that CTC offered

comparable success rates with lower per-patient costs and greater coverage, the Save the Children USA emergency health and medical staff, with technical assistance from Valid International, proposed a pilot CTC approach to supplement traditional therapeutic feeding center services. The merits of the approach were presented at a meeting with Ministry of Health representatives. Although most of the participants were skeptical about the effectiveness of the CTC approach and its advantages over other approaches, it was decided to implement this pilot program in the one woreda served by Save the Children USA, and it was eventually expanded to three woredas.

The first and essential step was to enlist the cooperation and participation of the local officials, the traditional healers and birth attendants, and the local communities. The nutritional status of the target population in the affected woredas had been previously assessed in biannual nutrition surveys, which gathered information on acute malnutrition, morbidity, mortality, and food security.

Save the Children USA relied upon a participatory planning process in which local woreda officials, traditional birth attendants, local volunteer community health workers, community-based reproductive health agents, and other local officials were invited to a meeting to discuss the problems of malnutrition in their area and strategies that might be used to address these problems. The outcomes of these initial meetings included the following:

» To enable the program to be targeted, local leaders identified the kebeles within the overall woreda that were most significantly affected by the drought and nutrition emergency.
» Local communities identified sites that could be used for weekly weighing of children and twice-monthly distribution of supplemental food, which preferably were attached to an existing health outpost.
» Local officials helped to identify candidates for the position of outreach worker, at least one of whom would be posted in each community.
» Local participants agreed to motivate their neighbors and friends to participate in screening of the children and helped to break down barriers to resistance. Local traditions often encourage parents of malnourished children to hide them away in shame or to keep children home who do not have proper clothes to wear, and the local leaders helped encourage community members to overcome their embarrassment for the sake of their children (Save the Children USA and Valid International unpublished documents; M. Gebremedhin, personal communication).

The Save the Children staff then identified local outreach workers to assist with the CTC process. The position of outreach worker was the most critical, because these workers had only minimal daily supervision and were on the front line for intervention in their communities. The outreach workers were initially required to have completed primary and secondary school (12 grades) to ensure they were fully literate in Amharic, to be respected within their communities, and to pass an examination on health issues designed by the Save the Children staff. As the implementation of CTC progressed, the literacy requirement was eliminated, because it became clear that the motivation and skills of the volunteers were more critical to their success than literacy per se. The outreach workers then received additional training from Save the Children staff on the warning signs of severe malnutrition, learned how to measure MUAC, and received additional weekly training in a variety of health education topics, including hygiene, HIV/AIDS, malaria control, breastfeeding, introduction of complementary food after the age of 6 months, and family planning.

Save the Children also provided training sessions on issues related to health and nutrition for local traditional birth attendants, reproductive health agents, and other volunteers. Complementary multisectoral programming activities trained local zonal officials and supported programs to protect water sources, install new hand pumps, rehabilitate latrines, and distribute insecticide-impregnated bed nets in areas of high malaria endemicity.

By mid-September 2003, the first CTC program was functioning. It was then rapidly expanded to three neighboring woredas. Each of the CTC programs had several components:

» A stabilization center referred the most severely malnourished children with medical complications, anorexia, or severe edema to a therapeutic feeding center or nutrition rehabilitation unit for inpatient care.
» Outpatient therapeutic feeding was provided for severely malnourished children who had no significant medical complications, a good appetite, and only minor edema. This program provided routine medication, clinical monitoring, and Plumpynut rations to children diagnosed as severely malnourished and fortified flour to their families.
» A supplementary feeding program for children with moderate malnutrition and for pregnant or lactating women provided a twice-monthly ration of premixed fortified flour, sugar, and oil and a routine medical package that included measles immunization, vitamin A and iron sulfate supplements, and deworming.
» At all program sites, health and nutrition education was provided, including demonstrations of the preparation of the premix.
» An outreach program provided follow-up of vulnerable cases in the home and community-based screenings and community mobilization activities.

In each community, parents voluntarily enrolled their children in the CTC program to receive treatment

for undernutrition. The trained outreach workers screened children on the basis of MUAC measurements. Children with a MUAC of 12.5 cm or more were sent home, and the rest of the children were sent for a secondary screening that included other anthropometric measurements. Children with weight-for-height less than 70% of normal, MUAC reading under 11.0 cm, or bilateral edema in their extremities were enrolled in the outpatient therapeutic program. Children with weight-for-height between 70% and 80% of normal were enrolled in the supplemental feeding program, even if their MUAC was close to 11.0 cm.

Children eligible for the outpatient therapeutic program were evaluated at admission by a trained nurse who took a medical history, including skin diseases and recent bouts of respiratory infections, diarrhea, or vomiting. The children then typically received a course of antibiotics and antimalarial drugs, immunization against measles, a dose of vitamin A to boost immune system function and protect vision, folic acid, and other medications, as directed by the WHO protocol for the management of severe malnutrition. A week after admission, an antihelmintic drug was administered. If the nurse found no significant complications or severe edema and the child was responsive and willing to eat Plumpynut, the child was then admitted to the outpatient therapeutic program. Children who did not meet these criteria were admitted to a stabilization center for more intensive care until their condition stabilized; they were then allowed to return home and were followed up in the weekly outpatient therapeutic sessions.

After the medical screening, the caregivers received instruction in the use of the ready-to-eat therapeutic food, Plumpynut. Each child was sent home with sufficient Plumpynut rations to last for one week, plus a supplementary ration of flour, oil, and soap. The addition of the other foods was intended to supplement the household food supply to discourage sharing of the critical Plumpynut ration, so that the target child would reap the optimal benefits. The OTP children were monitored weekly by a trained health worker at one of the community-designated program sites, and those who continued to make progress received the next week's ration of Plumpynut, flour, oil, and soap, as well as health and nutritional education. Failure to thrive might result in medical referrals or more intensive monitoring and health education by the outreach worker, depending upon the child's condition. After a child had attained a weight-for-height of more than 80% of the median at two successive weighings, the child graduated to the supplemental feeding program. Children with MUAC readings below 11.0 cm typically do not show rapid improvement in MUAC and are therefore expected to participate in the program for a minimum of two months.

Children in the supplementary feeding program either were admitted directly because of moderate malnutrition (weight-for-height between 70% and 80% of the median of the reference) or graduated from the more intensive outpatient therapeutic program. After anthropometric assessment, registration, and a clinical check, the caretaker of the child was given a bar of soap and 4.6 kg of premixed fortified flour. The fact that many families gathered together at the distribution sites made it possible to provide health and nutrition education and conduct cooking demonstrations. Children in the supplementary feeding program also received primary health care services when warranted, such as treatment for illnesses, immunization, and micronutrient supplementation. Many families had more than one child under five enrolled in the supplementary feeding program; the record was five children from a single mother. A child was discharged from the supplementary feeding program after two successive weight-for-height values of at least 85% of the median. The Save the Children staff continuously monitored the aggregated data from the children enrolled in the outpatient therapeutic program and the supplementary feeding program for ongoing evaluation of program effectiveness. These data represent summaries of program results from multiple communities and are thus useful for program evaluation, but they do not represent the results of a controlled clinical trial in which the outcomes for individual children are monitored.

Results

In examining the impact of the initial phase of the CTC program, the effects on several levels should be noted: first, the relative success in effecting improvements in child nutrition, and second, acceptance of the program by the beneficiary community.

Evidence of success of CTC in alleviating malnutrition

The first criterion for evaluation is the outcome of case management for malnourished children. The most controversial component of the CTC approach is the management of severe malnutrition at home by weekly weighings, provision of Plumpynut rations, clinical monitoring, and follow-up by outreach workers who are nonprofessional medical personnel, rather than management in therapeutic feeding programs with skilled-care personnel available 24 hours a day. Many of the professional staff initially assigned to implement the CTC program were skeptical of the efficacy of nonmedical care. They questioned the ability of minimally trained nonprofessionals and a largely illiterate population to manage the complex problems associated with severe malnutrition; but by the conclusion of this experience, the experts in both nutrition and

medicine were largely convinced of the success of the CTC program.

Data from this initial effort to apply a community-based approach demonstrate that the prevalence of malnutrition is reduced both by directly addressing the needs of affected children and by preventing those at risk from a deterioration in nutritional status through preemptive public health services and supplemental food rations. By the 16th week of operations in one woreda for which reliable data are available (Arbegona), the program was able to rehabilitate 66.0% of severely malnourished children sufficiently that they were able to graduate out of the outpatient therapeutic program to the less intensive supplementary feeding program, with the remainder continuing in the outpatient therapeutic program. The overwhelming majority of children (87.8%) were discharged after attaining adequate weight-for-height; only 8.8% required referral to a medical facility because of unsuccessful treatment or underlying medical complications. Only 2.3% defaulted from participation (defined as failure of a child to participate in anthropometric monitoring and food distribution for two successive weeks), and less than 1% died. These are all more positive outcomes than the minimums established in the international Sphere Project guidelines for humanitarian response [18]. Survey results obtained during and after the emergency phase showed a marked trend toward the reduction of mortality among children under five years of age (under-five mortality) and in the rate of severe acute malnutrition. In September 2003, the daily under-five mortality was 1.47/10,000 and the rate of severe acute malnutrition was 1.0% (95% confidence interval, 0.5–2.0); by March 2004 these rates had improved to 0.45/10,000 and 0.6% (95% confidence interval, 0.2–0.9), respectively.

When we compare the data from Arbegona with referent data, both positive and negative conclusions may emerge. A study of a previous CTC program in the same area of Ethiopia by Collins and Sadler found higher rates of recovery from malnutrition, but also higher rates of mortality and defaulting [17]. In all cases, the results from the Collins and Sadler study exceeded the Sphere Project guidelines, and in several ways the Arbegona data did not (see **table 1**).

TABLE 1. Outcome of the CTC program in Arbegona, Ethiopia, compared with Sphere Project guidelines and outcome of the CTC program in Ethiopia studied by Collins and Sadler

Outcome (%)	Arbegona	Sphere Project [18]	Collins and Sadler [17]
Death	0.2	< 10	4.1
Default from the program	2.3	< 15	4.7
Recovery[a]	66.0	> 75	85

a. Recovery was determined by graduation to a supplemental feeding program.

There are important differences between the results reported by Collins and Sadler and those from Arbegona that must be noted in trying to interpret the evidence of success in Arbegona. Collins and Sadler's retrospective cohort study intensively tracked a small number of children (170), and therefore it was easier to keep accurate records in their study. It also appears that funding was specifically designated for this research and monitoring, so that care with data collection was an important goal from the outset. In addition, the Arbegona data were obtained from a CTC program only 16 weeks after its inception, while the program was still operating. Since previous research has indicated that the rate of weight gain among children in a CTC program is slower than that achieved with therapeutic feeding center rehabilitation, it is plausible that the rate of recovery would have been higher if data had been available at the point when the CTC program was concluded. The fact that children in CTC programs gain weight somewhat more slowly than those in a medicalized therapeutic feeding center setting is not necessarily a significant drawback of the CTC approach. Because both the child and the parent are able to remain at home, there is less pressure for the child to be discharged from the outpatient therapeutic program so that the parent can return to other responsibilities, and therefore there is greater willingness to continue participation for the full duration of the program.

Despite these qualifications, there is reason to characterize the Arbegona case as successful. First, it reached a very large number of severely malnourished children where the need was apparent, and the great majority of those children improved markedly during the course of the program. The magnitude of the program and the rate of coverage illustrate the effectiveness of this approach, since more traditional therapeutic feeding centers could not begin to manage the volume of cases addressed in the program. The Save the Children programs admitted 5,799 severely malnourished children over a 5-month period, 3,765 of whom (64.9%) progressed sufficiently to graduate to the supplementary feeding program. An additional 7,961 children received services through the supplemental feeding program, illustrating the scope and magnitude of the food insecurity [14, 20]. The default rate was low, indicating community acceptance of the approach. Mortality was extremely low. This is surprising, given the poor health and sanitation infrastructure in the area, which exacerbates the problems caused by the initial malnutrition.

Another measure of effectiveness is the proportion of the at-risk population who received nutrition rehabilitation as a consequence of meeting eligibility criteria. Deconinck [20] reported that a survey to determine the proportion of the acutely malnourished receiving assistance in the Hulla and Arbegona districts found that "the coverage rates were excellent: OTP coverage was 78.3% and supplementary feeding program

coverage 86.8%. The success of the CTC program was largely due to the intensive outreach program where outreach workers closely monitor the children of affected communities and provide health education at the grass-roots level." This result compares very favorably with the Sphere Project guidelines, which target rural coverage rates at more than 50% [18].

Community acceptance of CTC

Participation by the beneficiary communities was quite robust. The local officials participated in the planning and implementation of the program from the outset, from organizing distribution centers to encouraging their community members to participate. Local leaders encouraged people to bring their children for screening and discouraged them from feeling shame at having a malnourished child by reminding the community members that the welfare of the children was paramount and by enrolling their own children in the CTC program.

The CTC staff held monthly meetings with local leaders to discuss the progress of the program and to fine-tune it as needed. Weekly staff meetings of all the outreach workers in each woreda permitted them to report on their progress, submit their summary data, and receive additional training on issues that they relayed to communities where they were assigned, such as hygiene, malaria control, diarrhea management, and family planning. The outreach workers tried to engage the people in dialogue and to have teachable moments whenever possible during home visits for monitoring enrolled children, in churches, at funerals, in schools, at community gatherings, and over the many cups of coffee that are part of Ethiopian social life.

CTC staff engaged in discussion and training with traditional herbalists and birth attendants in an effort to enlist them in the promotion of health in their communities. A measure of success has been that they brought their own children to the weighings. The herbalists also acknowledged that their medicines were fairly ineffective at treating kwashiorkor (*butama)* and marasmus (*amayesa*). An earlier assessment (J. Lee, unpublished document) suggested that traditional approaches to the treatment of kwashiorkor and marasmus may actually exacerbate these conditions, because herbal purgatives are used to induce vomiting and expel the "harmful germs" believed to cause the ailments. Even if they stood to lose income by losing patients, the traditional healers agreed to refer such cases to the CTC program.

Additional evidence of community acceptance of the CTC program is provided by the high levels of participation and low rates of withdrawal from the program. For example, in Arbegona woreda only 2.3% of the children who were enrolled defaulted, as measured by failure to be weighed at two successive weighings, and the SFP program had similar success. These results suggest that the CTC program met keenly felt needs among members of the community and that they perceived benefits from continued participation in the program.

Conclusions

Why was the CTC strategy successful? When we examine the timing and nature of aid in this instance, we note that success was attributable in part to the technical expertise and appropriate aid that were directed to these communities, but that social and community-based variables were also important. Local participation in the planning and implementation of the CTC program at many levels accounts for its effectiveness.

- Reports of problems resulting from drought reached the Disaster Prevention and Preparedness Commission (DPPC), which conducted a rapid assessment and sought assistance from zonal and regional offices, but they were unable to fully respond because of the magnitude of the emerging problem. The DPPC documented the effects of the drought, which included a total loss of cereal crops, a severely diminished harvest of ensete and vegetables, and a drop in income received from cash crops, especially coffee, all of which resulted in a food emergency.
- Regional and zonal health officials understood the importance of improved coverage and therefore allowed the CTC program to be piloted.
- Donor agencies and international nongovernmental organizations quickly coordinated and mobilized support for emergency aid.
- Community leaders and people with influence in local communities participated in the initial discussions and helped identify the communities to be targeted, thus helping to mobilize local support and participation.
- Community opinion leaders enrolled their own children in the CTC programs.
- Outreach workers were recruited from the communities that they served.
- Outreach workers were familiar with the people in the community and were thus able to overcome their reluctance to acknowledge the declining nutritional status of their children.
- The twice-monthly food ration distributions and the anthropometric assessments were performed in a highly public setting and were based in each targeted community. This ensured transparency in the process, which reinforced the face-to-face familiarity of people who recognized that they shared common problems and reduced possible accusations of favoritism or unequal distribution of resources.
- Local service providers—traditional birth attendants and reproductive health agents (health workers who

distribute contraceptives and provide HIV/AIDS education)—received additional training that may improve their effectiveness in service delivery in the long term.

» Outreach workers, community leaders, and members of each community were empowered as they learned that they had the ability to manage a serious local crisis, and this success should be a foundation for effective community-based planning and management in the future.

Although exit strategies should always be part of a plan to deal with an emerging crisis, this program, because of its strong emphasis on community management of problems, appears to be an ideal opportunity to bridge the divide between relief and development. The community mobilization presents an effective entry point for the complementary activities that target improvements in food security, local knowledge of improved health and nutrition practices, and infrastructure. The major crisis in the region has been averted for the time being, but it is clear that long-term nutritional problems persist, since the majority of children remain at least moderately to mildly malnourished. The food security situation remains precarious, and communities may not have sufficient resiliency to prevent another nutritional emergency unless the more fundamental problems of food production are addressed.

For at least 20 years, professionals in economic development have debated about how to meaningfully empower local people to be participants in change in their own communities, discussed what constitutes sustainable development, and pondered how to make a bridge from relief to development. In Ethiopia in particular, Marchione and Novick [9] noted the need to shift the emphasis from famine relief to famine prevention. One way to approach this problem is through wider implementation of community-based therapeutic care, since the approach is contingent upon high levels of community involvement and mobilization. Although high levels of intervention may be necessary at the outset of a nutrition emergency, CTC programs have the potential to bring technical knowledge to local community outreach workers rapidly and to mobilize the necessary supplies. Consequently, this intervention can be articulated as a phase in the process, and not as the end in itself. The issues that remain in SNNPR are many and diverse: water and sanitation systems are woefully inadequate, the high birthrate and small landholdings exacerbate population pressure, poor health infrastructure makes primary health care delivery problematic, and low agricultural productivity in relation to population size makes chronic food insecurity and periodic emergencies inevitable. These are all problems that development programs can address, and the positive community involvement that the CTC program has fostered is a sound foundation for the implementation of participatory development strategies in a comprehensive development program.

We believe that wider implementation of community-based care has the potential to foster the transition from effective emergency to development programming, and that future application of CTC strategies should examine the feasibility of this goal at the planning stages. Construction of this bridge to longer-term development approaches will require changes in both the donor and the implementing agencies. Young and Jaspars [21] have noted the reluctance of international donor agencies to become involved in food-aid programs unless the situation is dire. As a result, seasonal or mild shortfalls of food may precipitate full-blown famines. In a similar vein, many donor agencies and nongovernmental organizations make sharp distinctions between emergency and development programming. They often have separate funding streams, decision makers and staff, and policy and programming for emergency versus development work. Addressing these logistic and organizational barriers in the international humanitarian community and increasing reliance on community-based strategies may prove an effective strategy for making the transition from relief to development. The strength of CTC is that it builds capacity and coordination within local communities, because they become their own agents of change. As an additional tool in the arsenal of participatory development strategies, CTC may become an effective first step in both nutrition rehabilitation and longer-term development programming.

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Promotion of the Feeding Minds and Fighting Hunger initiative in selected rural schools in Andhra Pradesh, India

Mahtab S. Bamji and P. V. V. S. Murthy

Commentary

The following paper by Bamji and Murthy is, in keeping with the intention of the Food and Agriculture Organization (FAO) program developers, broadly applicable outside of rural India, and demonstrates a great deal of effort and enthusiasm by the authors, the teachers, and the schoolchildren. It is reasonable to ask, however, how relevant is the educational effort to the needs of poor people in less developed countries? The responses that the schoolchildren gave were sometimes surprisingly sophisticated: they clearly understood the role of poverty and demographic factors. Their knowledge of nutrition was quite general, the things they learned were pertinent, but in the end it seems unlikely that the nutritional state of people in the communities improved.

While this commentator is not familiar with the villages in the study, it is well known that in rural India, pregnant and lactating women, weanling children, adolescent girls, and the elderly are most at risk and often simple additions to the diet can make a great difference. Emphasis on the serious consequences of malnutrition—on birth weight, lactation performance, stunting in growth and development, and impaired immunity leading to higher mortality in young children—would have been helpful. Thus, one might wish that the effort had been more focused on specific target population groups, the impact of malnutrition in those groups, and specific ways to improve the nutritional situation of those in the most vulnerable groups.

The results show that the knowledge of the children in the program did improve, but how that new knowledge will translate into better nutrition in the community is not apparent. It is not unreasonable to assume that gradual improvements in the general knowledge of nutrition will eventually improve the nutritional status of the community, but this will surely be a slow process.

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Abstract

Background. *Schoolchildren are good agents of change and need to be educated and sensitized to specific issues of hunger and malnutrition through a question-and-answer process. Feeding Minds and Fighting Hunger (FMFH), a global project initiated by the Food and Agriculture Organization and partner organizations, attempts to help schoolchildren learn about these issues by introducing concepts in the prevention of hunger and malnutrition to teachers, and by facilitating transfer of knowledge to the children through a set of model lessons.*

Objective. *To test the feasibility of the FMFH approach to improve the nutrition knowledge of rural schoolchildren in three rural schools in Medak District of the South Indian state of Andhra Pradesh.*

Methods. *Participatory workshops for teachers were conducted to facilitate knowledge transfer to the children through interactive classroom teaching and other activities. The change in knowledge and thinking of children in the seventh and eighth grades was assessed by a ques-*

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*The editors of the *Bulletin* note with sadness that Dr. Wray died on March 9, 2006.

tionnaire administered before and after the intervention. The questionnaire also assessed, in part, the status of local food security based on the sources of different food items in the households.

Results. *The responses to the questionnaire suggested that the children's knowledge of nutrients and their functions was not good initially but improved after the intervention. However, their understanding of the social factors responsible for hunger and malnutrition was fairly good prior to the intervention. Improvement in responses to the question of what should be done to combat malnutrition also occurred after intervention. The community had village-level food security for rice and maize but depended partially or fully on outside sources for pulses, fruits and vegetables, and animal products.*

Conclusions. *The FMFH approach can be applied in rural schools where "the poorest of the poor" children can improve their understanding of balanced diets, better nutrition, the causes of malnutrition, and approaches to combat malnutrition.*

Key words: Classroom teaching, Feeding Minds and Fighting Hunger, food security, India, nutrition knowledge, rural schoolchildren

Introduction

Feeding Minds and Fighting Hunger (FMFH) is a global education initiative for schools designed to enable and encourage children and youths to become actively involved in helping to create a world free from hunger and malnutrition. Led by the Food and Agriculture Organization (FAO), other United Nations partners, and other regional and international organizations, it consists of materials and model lessons designed to enhance classroom teaching regarding key aspects of hunger, malnutrition, and food security.

To combat malnutrition in rural communities, the Dangoria Charitable Trust is striving to adopt the "three-A" approach of creating **A**wareness about food and nutrition in the community and improving **A**ccess to diverse foods at an **A**ffordable price. Associated issues of sanitation and health-care outreach are also being addressed [1–3]. Schoolchildren are good agents of change, and our earlier experience has shown that they communicate what they have learned to their parents and demand change, hence the usefulness of this approach is likely. Children need to be educated and sensitized to specific issues through a process of questioning and seeking answers. Children in rural schools in India tend to be educationally deprived. Yet they are keen learners, and hunger and malnutrition are realities in their everyday life. Teachers in rural schools, even though they have the necessary qualifications to teach, are not adequately knowledgeable about the subject of food and nutrition, and they need some help in teaching and discussing these subjects in class. Hence the FMFH project was introduced in three government-run rural high schools in the Medak District of the South Indian state of Andhra Pradesh. Children in grades 7 and 8 (age 12–13) were the target group. The major objective of the project was to promote the organization of activities involving teachers and students in select rural schools by using the FMFH model lessons [4], and to examine the impact of this effort on children's knowledge and understanding of food and nutrition, factors responsible for hunger and malnutrition, and to make them think about possible remedial measures.

Methods

Three government schools, which serve the poorest of the poor families living below the poverty line, were selected: Zilla Parishad Girls' High School in Narsapur, Government Boys' High School in Narsapur, and Zilla Parishad High School in the village of Reddipalli, 7 km from Narsapur, the Mandal (administrative block) headquarters. Most of the children attending government schools are from families below the poverty line.

Ethical approval for the project was obtained from the trustees of the Dangoria Charitable Trust. After discussing the project with the school and district authorities and obtaining their approval, we selected two teachers from each school, one of whom was the science teacher. Unfortunately, the science teacher from the Zilla Parishad Girls' High School dropped out for personal reasons, so that only five teachers could participate. Except for one science teacher with a biology background who had some knowledge of food, nutrition, and health, the others were poorly informed on these subjects. Oral informed consent was obtained from the parents of the children for their participation in the project.

The project was launched during World Food Week in October 2003. On the day of the launch, morning assemblies were held in the schools in which the project was explained to the teachers and children, a nutritious groundnut-based sweet was distributed instead of the usual sugar sweet, a march through the village of Narsapur was conducted with displays of banners and placards on hunger and nutrition and the importance of World Food Day, and a formal inaugural function was held that included agriculture and nutrition scientists, local dignitaries, children, parents, and teachers. The organizers and dignitaries gave speeches and the children sang songs. Prizes were given to those children who had done well in the initial questionnaire on food and nutrition. The guest of honor was an eminent

agricultural scientist with a keen interest in nutrition. Three teachers' sensitization and training workshops were conducted with the use of a participatory, learner-centric approach. The FMFH model lessons were translated into the local language (Telugu) with culturally appropriate modifications. Classroom activities for the children included discussion of the daily diet to identify deficiencies, reasons and scope of improvement within the present financial constraints, a drawing competition, a "message of the day" written on the chalkboard and discussed, and planting of school vegetable gardens at two of the three schools.

A questionnaire on nutrition and food sources (see the Appendix) was administered to 15 to 22 children from each school initially and again at the end of the project. Children with superior academic performance and willingness to participate and with more than 80% attendance were identified by teachers to answer the questionnaire; project staff members explained the quiz to the children. An attempt was made to assess the children's knowledge of food and nutrition (e.g., nutrients, their functions, food groups, and nutritional deficiencies) with objective questions that could be scored. The grading scale was from 0 to 100.

The data were analyzed by Student's *t*-test to assess the significance of the difference between two sample means. In addition, open-ended questions were asked to assess knowledge and thinking on questions such as who is hungry, why are people hungry, what can be done to ameliorate hunger, who are some local heroes who have helped to fight malnutrition, and the like. In order to assess local food security, the children were asked where the households procured food items such as rice, wheat, maize, other millets, pulses, tubers, vegetables and fruits, milk, and eggs—from their own fields, the village market, a nearby village, or a weekly market in a nearby big village or town. The option of answering "Don't eat" for specific items was also given. The children were not asked about the frequency of consumption of different food items.

Toward the end of the project (February 2004), food and nutrition exhibitions were held in each of the three schools. The exhibits included charts, models, and live displays of local foods with their nutritional importance explained and balanced diets described. In addition to the exhibits prepared by the teachers and children (20 charts, two three-dimensional models showing distribution of hunger in the world, and live models) were charts from the Dangoria Charitable Trust. Charts were also obtained from the National Institute of Nutrition in Hyderabad, the State Food and Nutrition Board in Hyderabad, and a mobile exhibition prepared by the Hyderabad chapter of the Indian Women Scientists Association. Students were trained to explain the charts at the exhibitions. On request, teachers from the local ICDS (Integrated Child Development Scheme) centers, who are trained in nutrition, also helped. Wide publicity was given to the exhibition and parents and children from other schools were invited to visit the exhibition.

Results

Cooperation of the schools and district authorities

Initially the principals and the teachers were hesitant to start the project because they did not have the time and felt unprepared. However, after some explaining, they reluctantly came forward, and after the first workshop they became interested and enthusiastic. Fortunately, the local Mandal Development Officer was greatly interested and gave full cooperation. The District Collector was interested and readily gave permission for the project. The middle-level authorities were not uniformly cooperative but eventually supported the project.

The teachers found the project useful and interesting and, despite their initial hesitation, prepared good charts for the exhibition with the help of the children. They said that they had incorporated what they learned in their classes in different ways and that they wanted the project staff to visit as frequently as possible. Full cooperation was given to the project staff in classes, which were made interesting through a question-and-answer approach. The children enjoyed the project, because rural schoolchildren seldom get opportunities of this kind.

School gardens

Planting material for the gardens was provided and the gardens were set up. However, watering is a problem, particularly during summer vacations, and only one of the two gardens continues to be maintained.

Exhibitions

More than 1,700 children from various schools visited the exhibitions in the three schools on different days. Although the high level of attendance sometimes made it difficult to handle the crowds, the student volunteers were enthusiastic and explained the charts well. The "snake and ladder" games on the nutrition charts were very popular. The disappointing aspect was that very few parents came, even though they were invited. This lack of attendance was attributed to the fact that it was the active farming season, a time when most parents were busy in their fields during the day when the exhibitions were conducted.

Questionnaire for the children

Table 1 shows that children's knowledge regarding

TABLE 1. Performance of the children in the FMFH questionnaire (mean ± SD percentage score)

School	Grade 7		Grade 8	
	Initial: Oct 2003	Final: March 2004	Initial: Oct 2003	Final: March 2004
Zilla Parishad Girls' High School, Narsapur	41.8 ± 11.20 (n = 20)	46.2 ± 10.30 (n = 15)	51.0 ± 11.50 (n = 19)	56.7 ± 9.80 (n = 19)
Government Boys' High School, Narsapur	27.0 ± 9.65 (n = 20)	69.1 ± 14.40*** (n = 18)	44.0 ± 8.57 (n = 20)	78.5 ± 12.02*** (n = 18)
Zilla Parishad High School, Reddipalli	34.8 ± 9.68 (n = 21)	78.1 ± 5.87*** (n = 22)	54.3 ± 6.27 (n = 20)	68.0 ± 7.85*** (n = 22)

*** $p < .001$ compared with the initial scores

nutrients and their functions (questions 1–7), as tested by objective multiple-choice questions, improved significantly ($p < .001$) as a result of the FMFH intervention. Initially the Zilla Parishad Girls' High School in Narsapur scored as well as or better than the other two schools, and the first two prizes went to girls from that school. In the final test, the Government Boys' High School in Narsapur and the Zilla Parishad High School in Reddipali performed better. This was not surprising, because the teachers in those two schools were more enthusiastic and motivated than those in the Zilla Parishad Girls' High School. In the latter school, as mentioned earlier, the science teacher dropped out for personal reasons; the social studies teacher was interested but had time constraints. Children in grade 8 tended to perform better than those in grade 7, except for the final test in the Zilla Parishad High School in Reddipalli, when the seventh-grade scores tended to be higher than the eighth-grade scores.

Responses from the students on the who and why of hunger and malnutrition

The children gave a variety of answers to questions on the who and why of hunger and malnutrition. Most children attributed hunger and malnutrition to poverty (**table 2**). Other important causes included landlessness, being an orphan and destitute, and unemployment. A few children also mentioned working as a child laborer, illiteracy, and crop failure. Causes such as poor knowledge of nutrition, being a child or a pregnant woman, and being a victim of war were mentioned only in the final test. (The answers to these open-ended questions are summarized in **tables 2** through **4**.)

The major responses to the question "What should be done to ensure that everyone gets a balanced diet?" are listed in **table 3**. Many children answered "Everyone should do agriculture" and "work hard." Few children mentioned owning land, cultivating a variety of crops, growing fruits and vegetables, and making food available at low cost. Ensuring food security, increasing awareness of nutritious foods, and improving transportation were mentioned only in the final test, probably because they were mentioned in the FMFH lessons.

Among the most frequent responses to the question "What can affect food production in the country?"(**table 4**) were lack of water, fertilizers, manure, seeds, pesticides, and agricultural equipment; damage by crop pests, birds, and cattle; population explosion; deforestation; adulteration of seeds and fertilizers; and illiteracy.

Only some children were able to name two rich countries, such as the US and England, where very few people are hungry (question 16). Several great people, mostly political heroes and sports figures, were mentioned as having helped the poor. Few children mentioned scientists such as M. S. Swaminathan (a leading agricultural scientist, responsible for initiating the Green Revolution in India, which gave India food security for wheat and rice), Nobel laureate C. V. Raman,

TABLE 2. Responses to Question 8: Who suffers from hunger and malnutrition? (multiple responses)

Response	Initial (n = 120)[a]	Final (n = 114)[a]
	no. (%)	
Poor people	101 (89.4)	112 (98.2)
Beggars	18 (15.9)	7 (6.1)
Orphans and destitute people	15 (13.3)	43 (37.7)
Landless people	14 (12.4)	23 (20.2)
Sick people	7 (6.2)	—
Mentally ill	4 (3.5)	1 (0.8)
Victims of crop failure	3 (2.6)	22 (19.3)
Old people	3 (2.6)	—
Physically handicapped	3 (2.6)	2 (1.7)
Homeless	3 (2.6)	7 (6.1)
Unemployed	2 (1.8)	14 (12.3)
Those having large families	2 (1.8)	1 (0.8)
Illiterates	1 (0.8)	7 (6.1)
Child laborers	1 (0.8)	7 (6.1)
Those who have poor knowledge of nutrition	—	8 (7.0)
Small children	—	14 (12.3)
Pregnant women and small children	—	20 (17.5)
Victims of war	—	5 (4.4)
No response	7 (6.2)	—

a. Number of respondents, both classes combined.

TABLE 3. Responses to Question 9: What should be done to ensure that every one gets a balanced diet? (multiple responses)

Response	Initial (120)[a]	Final (114)[a]
	no. (%)	
Everyone should do agriculture	45 (43.3)	22 (21.8)
Work hard	27 (26.0)	15 (14.8)
Own land	7 (6.7)	1 (0.9)
Have a small family	6 (5.8)	4 (3.9)
Grow fruits and vegetables	6 (5.8)	7 (6.9)
Farmers should cultivate a variety of crops (diversification)	5 (4.8)	12 (11.9)
Increase production	4 (3.8)	10 (9.9)
Food should be available to all at low cost	4 (3.8)	12 (11.9)
Have employment	4 (3.8)	1 (0.9)
Help the poor	4 (3.8)	7 (6.9)
Everyone should be educated	3 (2.9)	1 (0.9)
Work together (cooperate)	3 (2.9)	3 (2.9)
Promote home gardening	2 (1.9)	5 (4.9)
Keep dairy cattle	1 (0.9)	1 (0.9)
There should be awareness regarding nutritious food	—	14 (13.8)
Ensure food security	—	19 (18.8)
Improve transportation	—	17 (16.8)
No response	16 (13.3)	13 (11.4)

a. Number of respondents, both classes combined.

and Abdul Kalam (an eminent scientist who is also the current President of India). No musicians or artists were mentioned, although actor-politician N. T. Rama Rao was mentioned. In the final questionnaire, some children mentioned the name of Dr. Bamji (project consultant) also.

Source of food items for home consumption

The question "Where does your family get the following foods," with options such as own farm, same village, weekly market in nearby big village combination, and don't eat, was asked to get some idea of access to food within the village.

The responses (**table 5**) show that whereas village-level availability was good for cereals, millets, maize, sorghum, milk, and eggs, more than 50% of households had to depend on sources outside the village for pulses, fruits, and vegetables.

Discussion

For food and nutrition security, one has to have **A**wareness, **A**ccess, and **A**ffordability regarding food and nutrition. Generation of awareness enables a poor community to make wise choices and demand the right types of food. Children are good agents of change, and our earlier experience has shown that they demand things from their parents and question them, and hence this FMFH approach is useful even for poor people in developing countries, despite resource constraints.

TABLE 4. Responses to Question 12: What can affect food production in the country? (multiple responses)

Response	Initial (120)[a]	Final (114)[a]
	no. (%)	
Lack of water, fertilizers, manure, seeds, pesticides, and agricultural equipment	62 (70.4)	59 (59.6)
Damage from crop pests, birds, and cattle	13 (14.8)	6 (6.0)
Population explosion	12 (13.6)	15 (15.1)
Deforestation	8 (9.0)	2 (2.0)
Inadequate transportation	5 (5.7)	3 (3.0)
Political interference	5 (5.7)	2 (2.0)
Drought	4 (4.5)	2 (2.0)
Failure of bore wells	2 (2.3)	2 (2.0)
Mineral deficiency in soil	2 (2.3)	2 (2.0)
Single crop	2 (2.3)	1 (1.0)
Lack of money and loan facilities	1 (1.1)	1 (1.0)
Transport strikes	1 (1.1)	—
Poor technical knowledge about new methods of agriculture	1 (1.1)	18 (18.2)
Lack of irrigation facility	—	8 (8.0)
Environmental pollution	—	1 (1.0)
Seed or fertilizer adulteration	1 (1.1)	22 (22.2)
High price of farming material	—	5 (5.1)
Interference from middlemen	1 (1.1)	2 (2.0)
Illiteracy	1 (1.1)	8 (8.1)
No response	32 (26.6)	15 (13.1)

a. Number of respondents, both classes combined.

Our results show that the promotion of the FMFH initiative in the government-run rural schools where the poorest of the poor children are educated had a positive impact on children's knowledge of nutrients and their functions (**table 1**) and to some extent on issues such as the what, who, and why of hunger and strategies for combating hunger, as assessed by a questionnaire administered at baseline and at the end of the initiative. The fact that students in the two schools in which the teachers attended the workshop and were motivated did better than those in the government girls' school, in which the science teacher dropped out and the other teacher could not devote much time to the project, stresses the importance of the teachers and the need to educate them. Although the children's knowledge of the science of food and nutrition was initially poor (**table 1**), their knowledge of the social aspects of malnutrition and hunger was quite mature. Hunger and malnutrition are realities that these chil-

TABLE 5. Responses to Question 13: Where does your family get the following foods?[a]

Food	Own field	Same village	Nearby village/ weekly market in nearby big village	Own village and other village	Do not eat
	no. (%)				
Rice	80 (66.6)	19 (15.8)	4 (3.3)	17 (14.2)	—
Wheat	43 (35.8)	46 (38.3)	15 (12.5)	9 (7.5)	7 (5.8)
Jowar (sorghum)	66 (55.0)	25 (20.8)	12 (10.0)	9 (7.5)	8 (6.6)
Ragi (finger millet)	28 (23.3)	24 (20.0)	32 (32.3)	4 (3.3)	32 (26.6)
Maize	84 (70.0)	18 (15.0)	12 (10.0)	—	6 (5.0)
Pulses	19 (15.8)	51 (42.5)	19 (15.8)	31 (25.8)	—
Potato	12 (10.0)	58 (68.3)	40 (33.3)	3 (2.5)	7 (5.8)
Onion	47 (39.1)	45 (37.5)	20 (16.6)	8 (6.6)	—
Green leafy vegetables	52 (43.3)	38 (31.6)	15 (12.5)	11 (9.1)	4 (3.3)
Other vegetables and fruits	13 (10.8)	43 (35.8)	59 (49.1)	5 (4.1)	—
Milk	40 (33.3)	43 (35.8)	28 (23.3)	—	9 (7.5)
Eggs	15 (12.5)	72 (60.0)	23 (19.1)	—	10 (8.3)
Meat or fish	3 (2.5)	34 (28.3)	51 (42.5)	—	32 (26.6)

a. Initial responses only.

dren live with. How to respond to the questionnaire was explained to the children with examples and it was administered in the local language, and therefore the children were able to understand the questions. The children who answered the questionnaire not only had better school attendance but also had a good record of scholastic performance, as shown by examination grades. Such non-random (purposive) selection can be regarded as a limitation of the present study for judging the impact of our intervention. However, even the other children showed keen interest and participated enthusiastically in the classroom activities and the exhibitions.

The children's responses to the question about the sources of different foods for their households suggest that all the families consumed rice, which they got from their own village and mostly from their own fields. Most families consumed wheat, maize, and sorghum (but not daily); most of the maize, and to lesser extent the sorghum, was grown in their own fields or purchased within the village. Wheat was sold in the ration shops in the villages through the public distribution system. However, food security (access) for foods such as pulses, vegetables and fruits, and some animal products appears to be less satisfactory, since they have to be procured from outside the village. Clearly there is a need to promote agricultural diversification by promoting production of legumes, horticulture and home gardening, and animal husbandry.

For promoting school gardens, a reliable supply of water and compound wall or proper fencing has to be ensured. Mechanisms for looking after the garden during the long summer vacation have to be developed, with the participation of the children residing in the particular village.

This experience of the Dangoria Charitable Trust in promoting the FMFH initiative points to the need to adapt and promote the FMFH tools as part of wider multisectoral initiatives for addressing the issues of hunger, food insecurity, and malnutrition. However, this has to be a long-term continuing process, rather than an isolated intervention. Strengthening the nutrition component in teachers' training would go a long way toward creating awareness of nutrition in the community through the children. Creation of awareness is the first step toward meeting the goal of nutrition security, because with awareness comes demand and better planning for food production to improve access to a variety of foods, even within the financial constraints. However, since change in the nutrition status of the community is a slow process, one cannot expect any change from a brief intervention.

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Appendix

Feeding Minds and Fighting Hunger (FAO Questionnaire)

Questions 1–5 have one wrong answer. Cancel the wrong answer.

1. To lead a healthy life we need
   1) a balanced diet.
   2) a clean environment.
   3) to watch the cinema.
   4) regular exercise.

2. If children don't eat well, they
   1) remain short and thin.
   2) fall sick frequently.
   3) feel like playing all the time.
   4) get tired easily.

3. A healthy, balanced diet should include
   1) rice.
   2) roti (cereal or millet salty pancake).
   3) dal (lentil).
   4) chocolates.
   5) vegetables.
   6) fruit.
   7) milk.
   8) egg/meat/fish.

4. If a pregnant woman does not eat a good diet, she
   1) gets anemia.
   2) gives birth to a low-birthweight child.
   3) does not gain proper weight during pregnancy.
   4) has good eyesight.

5. Nutrients present in food are
   1) proteins.
   2) blood.
   3) carbohydrates.
   4) vitamins.
   5) iron.
   6) calcium.

6. Match the food item with the nutrient it provides the most.

Food	Energy	Protein	Iron	Calcium	Vitamin A	Vitamin C
Rice						
Dal						
Papaya						
Guava						
Lemon						
Carrot						
Meat						
Amaranth						
Oil						

7. Match the nutrients present in the food (column 1) with their most important function.

Nutrient	Gives energy	Gives more energy	Body building	Protects against diseases
Carbohydrates				
Proteins				
Fat				
Vitamins				

8. Who suffers from hunger and malnutrition (name them)?

_____
_____
_____
_____
_____

9. What should be done to ensure that every one gets a balanced diet?

_____
_____
_____
_____
_____

10. Kamala and Ramu are sister and brother. They had the following foods yesterday: rice, tamarind water, and chili. Do you think they can remain healthy on this kind of diet? Tick the right answer.
    1) Yes.
    2) No.
    3) Don't know.

11. If "no" to the above, what else should they eat to remain healthy?

    1. 5.
    2. 6.
    3. 7.
    4. 8.

12. What can affect food production in the country?

13. Where does your family get the following foods?

Food	Own farm	Same village	Nearby village/ weekly market in nearby big village	Same village and other village	Do not eat
Rice					
Wheat					
Maize					
Jowar (sorghum)					
Ragi (finger millet)					
Dals (pulses)					
Potatoes					
Onions					
Green leafy vegetables					
Other vegetables					
Milk					
Eggs					

14. Do you consume milk or curd daily?
    1) Yes.
    2) No.

15. If no, why not?
    1) Don't like it.
    2) Don't get it (i.e., not available in my home).
    3) Too expensive.
    4) Any other (describe).

16. Name the two richest countries where there are very few hungry people.

17. Name the two poorest countries where there are many hungry people.

18. Name any three past or present great people in the country who have helped the poor people.

19. Would you also like to help people and be great some day?

Child's gender and household food insecurity are associated with stunting among young Pakistani children residing in urban squatter settlements

Naila Baig-Ansari, Mohammad Hossain Rahbar, Zulfiqar Ahmed Bhutta, and Salma Halai Badruddin

Abstract

Background. *The nutritional status of children is a good indicator of the overall well-being of a society and reflects food security as well as existing health-care and environmental conditions. In Pakistan, it is estimated that nearly 40% to 50% of children under the age of five are stunted. Due to greater economic opportunities available to the urban population as compared to the rural, it was believed that economic resources existed in poor urban Pakistani households but that the households lacked the skills and knowledge to translate their resources into good care and feeding practices.*

Objective. *This study aimed 1) to assess the prevalent care and feeding practices among children aged 6 to 18 months residing in the squatter settlements of Karachi and 2) to identify care and feeding practices, as well as any other underlying factors, associated with stunting.*

Methods. *A cross-sectional survey was conducted in eight settlements between October and December 2000. A total of 433 mothers of eligible children were interviewed with the use of structured questionnaires. Final analysis using multiple logistic regression was conducted on 399 mother–child pairs.*

Results. *Female children were nearly three times more likely to be stunted than male children. Households that were food insecure with hunger were also three times more likely than other households to have a stunted child.*

Lack of maternal formal schooling (adjusted prevalence odds ratio, 2.9; 95% confidence interval, 1.4 to 3.8) and large household size (adjusted prevalence odds ratio, 1.7; 95% confidence interval, 1.0 to 3.8) were also associated with stunting. Even though certain care and feeding practices were significant at the univariate level, they were not significant in the final multivariate analysis and so were excluded from the final model.

Conclusions. *In households where food insecurity exists, knowledge of care practices may not be sufficient, and interventions such as food subsidies must precede or accompany educational efforts. Further follow-up is required to explore the effect of gender differences on child care.*

Key words: Anthropometry, children, food insecurity, gender, Pakistan, stunting

Introduction

The nutritional status of children is a good indicator of the overall well-being of a society and reflects food security as well as existing health care and environmental conditions. It is estimated that nearly 40% to 50% of children under the age of five in Pakistan are stunted, that is, of low height (or length)-for-age [1, 2]. Inadequate feeding and/or repeated illness are the immediate causes of stunting and can be exacerbated by some combination of household food insecurity, unhygienic environments, and the consequent inability of families to take care of their young adequately [3].

It has been reported by Begin et al. that early childhood malnutrition can fundamentally be attributed to poverty and lack of economic resources [4]. However, even in poverty-stricken communities with inadequate household food access, there are children who grow and develop normally as a result of positive family and caregiver behaviors [5–7]. Good care practice

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includes behaviors that pertain to feeding, home health care, food preparation, hygiene, and the provision of a responsive and stimulating environment to a child during its most vulnerable stage [8, 9].

In 1990, as part of its conceptual framework for malnutrition, UNICEF recognized care, along with food security and health, as an important underlying determinant of nutrition status for women and children. This framework argued that household food security, health, and care are all necessary conditions for achieving nutrition security, but none of the three is sufficient by itself [3].

Given the multiplicity of indicators involved in the assessment of infant feeding and care practices and the need for age-specific indicators, it is often difficult to summarize the information in an appealing and meaningful way. However, recently developed composite child-feeding indices may help to quantify the strength of the association between child-feeding practices *as a whole* and nutritional outcomes and to help assess the maternal and socioeconomic barriers to optimal feeding practices on children's health and nutrition. Composite child-feeding indices also provide useful information for advocacy and communication, since they can summarize disaggregated information in a single number. Such indices can be made age-specific and can include various dimensions of feeding practices [10].

Household food insecurity has been identified as a possible underlying determinant of malnutrition [3]. Development organizations and other institutions have had to measure household food insecurity for program design and targeting, but the existing measures of national food availability alone have been inadequate [11]. For almost a decade, the United States Department of Agriculture (USDA) Food and Nutrition Services food-security core module [12] has been a useful tool for measuring the severity of household-level hunger and food insecurity in the United States and Canada. The USDA food-security core module has been successfully adapted in countries [13] as diverse as Indonesia [14], Venezuela [15], and Brazil [16], as well as among different ethnic groups in the United States [17–19]. The results of three exploratory adaptations of the USDA module in India, Uganda, and Bangladesh indicated that the module was reasonably reliable with minimal modifications to the core questions [20].

In severely food insecure households, interventions pertaining to child care and feeding practices are unlikely to be sufficient for reducing malnutrition. In such households, other forms of nutritional intervention, such as supplementation, will need to be incorporated. However, among food secure or moderately food insecure households interventions to promote care practices related to the feeding and hygiene of a young child may well result in enhanced growth (in height or length and weight), since caregivers in these households have the capabilities but not the knowledge to implement good feeding practices and behaviors.

This study is the first to look at child caring practices individually as well as collectively to form a composite index relating to malnutrition among young Pakistani children. Recognizing care as an important component of UNICEF's conceptual framework of malnutrition, we hypothesized that while many poor urban households may have the economic resources they may not have the skills and knowledge needed to translate their limited resources into good care and feeding practices. The identification and subsequent promotion of better care practices may help reduce the risk of stunting despite a household's overall food and socioeconomic status.

With the multifaceted aspects of malnutrition in mind, a survey was conducted in Karachi, Pakistan. The aim of the study was to assess prevalent care and feeding practices among children 6 to 18 months of age residing in squatter settlements of Karachi and to identify care and feeding practices, as well as any other underlying factors, associated with stunting.

Methods

Study sample

The study was a community-based cross-sectional survey conducted in Karachi, Pakistan, from October through December 2000. It is estimated that nearly 50% of Karachi's 12 million people [21] live in squatter settlements. Eight squatter settlements were purposively selected for the survey on the basis of their present or past association with either a nongovernmental organization or the Aga Khan University. These affiliations were important to help the authors obtain support in the squatter settlement communities for their research. All households with at least one child between 6 and 18 months of age were eligible. In a household with more than one eligible child, the interviewer wrote the names of the children on slips of paper and randomly selected the study subject.

Oral consent was obtained from the child's mother after providing her with an explanation of the study. Consent was also obtained from a family elder, wherever required, in keeping with Pakistani traditional values. Any household that did not give oral consent was excluded from the study. Children with congenital deformities were also excluded because their need for special care is beyond the scope of "normal" caregiving practices. The Aga Khan University's Ethical Review Committee approved the conduct of this study.

Sample size

Because of the paucity of information regarding

child-care and feeding practices in Pakistan, the sample size was calculated on the basis of diarrhea incidence, one indicator of poor feeding and care practices [22]. With an estimated prevalence of diarrhea among nonstunted children of approximately 22.7%, a 95% confidence level, and a statistical power of at least 80%, a sample of 381 children was required to detect associations with an odds ratio of at least 2.0. After inflation of this number by 10% to account for refusals to participate, 420 study subjects were required to meet the study objectives.

Sampling strategy

Within each of the selected sites, households were selected systematically after a random selection of the first lane to begin the survey from. Data collectors then proceeded to count and mark every 10th house in the area from the first house of the randomly selected lane. Once the marking was complete, the first marked house was approached. If the household did not have an eligible child, the adjacent house was approached and so on until an eligible house was found. After completion of the interview, the next marked house was approached. The sample was not weighted according to settlement size.

Data collection

A questionnaire was developed to obtain information on care and feeding practices, as well as other variables of interest from the child's mother. Care practice questions used in the Complementary Feeding Care Index were included in this questionnaire. The questionnaire was developed in English, translated into Urdu, and then back translated into English. The questionnaire was pretested among 35 households living in a squatter settlement similar to those to be surveyed. Nutrient intake information was collected using a 24-hour dietary recall as well as a food-frequency questionnaire. Responses from the food-frequency questionnaire were used for assessing the nutrient intake part of the Complementary Feeding Care Index.

In order to minimize potential variability in measuring weight and height or length, only one supervisor, who was also a trained lady health worker, measured the children and their mothers. A lady health worker is a government-certified ancillary health worker who promotes the government of Pakistan's rural health and urban nutrition and health programs.

During the interview, the mother answered questions about the age, occupation, education, duration of marriage, and ethnicity of the parents; the mother's pregnancy status; the child's history of breastfeeding and complementary feeding; the child's age, sex, number of living siblings, place of delivery, and vaccination status; whether the child had ever had measles; and whether the child had had diarrhea in the past two weeks. The child's weight and length were measured to assess his or her nutritional status.

The mother was also asked about the availability of water and sanitation facilities in the house, the number of persons living in the house, the type of dwelling, total household income, home ownership, and cooking facilities. Household members were defined as all persons living under the same roof and using the same kitchen. These variables were used to assess the socioeconomic status of the household.

Food security within the household was assessed by a series of questions regarding food adequacy and financial constraints in the past 12 months. These questions were based on a household food-security module developed by the USDA Food and Nutrition Service to measure food insecurity and hunger in the United States [12]. The module uses an 18-item set of questions that asks whether a variety of behaviors or conditions had occurred within the past 12 months due to financial constraints. The module uses the responses to these questions to categorize household food security status as food secure (households with no or minimal indication of food insecurity), food insecure without hunger (households concerned about inadequate resources to buy enough food that have adjusted by decreasing the quality of their family diet, with little or no reduction in household food intake), and food insecure with hunger (food-insecure households in which one or more members have decreased the amount of food they consume to the extent that they have repeatedly experienced the physical sensation of hunger) [12].

Among other things, the questions asked about the mother's perception regarding the adequacy of food in the household and whether any adult, any child, or the mother ever had to skip or reduce a meal because of financial constraints. For the purpose of our study, the USDA food security module was translated into Urdu and then back-translated into English. The Urdu translation was pretested on 35 women, and modifications were made to the word "balanced meal," since the concept of a balanced meal was difficult to interpret among this population. By and large, the same questions that were used in the US version were used in our study.

The mother's weight was measured to the nearest 0.5 kg on a Tanita analogue weighing scale after confirmation that the scale was set at zero. After the mother's weight had been recorded, she was asked to step onto the scale holding the child, and the combined weight of the mother and child was recorded. The child was weighed wearing minimal clothing. At the time of data analysis, the child's weight was calculated as the difference between the combined weight of the mother and child and the mother's weight. A Salter scale was not used to weigh the child because it was unsure whether permission would be given or an appropriate place

could be found to hang the scales in the child's house.

The mother's height was measured as she stood on a flat surface without shoes with her back against a door. A ruler was placed over the mother's head and a light mark was made. Her height was measured with a standard haberdasher's tape. A UNICEF infant/child length measuring board was used to measure the child's recumbent length to the nearest 0.1 cm, following standard procedures [23]. The child's head was firmly secured, and the knees were extended to avoid any undue bending. Measurements were repeated twice, and an average of the two was used.

Data quality control measures

The data were edited daily by the field supervisors. Spot checks at two or three field sites were conducted on a daily basis by either the field supervisors or the principal investigator. The interviewers were not aware of the schedule for the spot checks. Open-ended questions or those questions where additional information had been provided were given codes by the principal investigator prior to electronic data entry.

The completed data were double-entered by two different data-entry operators using a data-entry program from Epi Info version 6.04c. Discrepancies identified between data-entry operators were corrected by checking the original questionnaire. After correcting for key-punch mistakes, the error rate in data entry was assessed (i.e., if both operators made the same mistake). Forty questionnaires were randomly selected by using the Epi Info version 6.04c option and rechecked by the principal investigator. Discrepancies were found in 0.3% of the entries, and they were corrected.

Data analysis

The dependent variable "stunting" was created by taking the child's recumbent length and converting it to sex- and age-specific z scores relative to the National Center for Health Statistics/World Health Organization (NCHS/WHO) standards [24] with the use of the Centers for Disease Control and Prevention Anthropometric Package v1.02 [25]. Stunting was defined as length-for-age less than –2 z scores. Those children whose z scores were greater than or equal to –2 were considered to be not stunted.

Items were identified for creation of the Complementary Feeding Care Index prior to analysis. The index was divided into two parts: nutrient intake and practices. Items included in the nutrient-intake part were intake of foods considered rich sources of vitamin C, iron and folic acid, and vitamin A (both animal and plant sources) as well as intake of tea. Items included in the practices part were divided into age-appropriate breastfeeding practices and age-appropriate complementary feeding practices. A negative practice

TABLE 1. Complementary Feeding Care Index

A. Child's nutrient intake included in the index

Based on the food-frequency questionnaire, key nutrient sources were scored as follows:

Vitamin C–rich sources

	No. of days consumed per week		
Food	0	1–4	5–7
Guava	–1	0	+1
Orange	–1	0	+1
Mango	–1	0	+1
Cabbage	–1	0	+1
Cauliflower	–1	0	+1
Potato	–1	0	+1
Sweet potato	–1	0	+1
Spinach and other green leafy vegetables	–1	0	+1
Tomato	–1	0	+1

Iron and folic acid–rich sources

	No. of days consumed per week		
Food	0	1–4	5–7
Meat	–1	0	+1
Fish	–1	0	+1
Poultry	–1	0	+1
Organ meats	–1	0	+1
Whole-grain wheat products (*chappati*)	–1	0	+1
Bitter gourd	–1	0	+1
Spinach	–1	0	+1
Nuts, legumes	–1	0	+1
Lentils: dal, chickpeas, kidney beans, mung beans	–1	0	+1

Vitamin A–rich sources

	No. of days consumed per week		
Food	0	1–4	5–7
Animal sources			
Egg yolk	–1	0	+1
Butter	–1	0	+1
Liver	–1	0	+1
Plant sources			
Mango	–1	0	+1
Papaya	–1	0	+1
Melon	–1	0	+1
Yam	–1	0	+1
Carrot	–1	0	+1
Tomato	–1	0	+1
Spinach	–1	0	+1

Intake of tea

	No. of days consumed per week		
	0	1–4	5–7
Tea	0	–1	–1

TABLE 1. Complementary Feeding Care Index *(continued)*

B. Practices included in the index

Practice	Response	Score according to age group (mo)		
		6–8.9	9–11.9	12–18
Breastfeeding practices				
Ever breastfed	Yes	0	0	0
	No	–1	–1	–1
Still breastfeeding	Yes	+1	+1	0
	No	–1	0	0
Months of exclusive breastfeeding	0–0.9	–1	–1	–1
	1–3.9	0	0	0
	4–5.9	+1	+1	+1
	≥ 6	–1	–1	–1
Complementary feeding				
Vitamin supplementation	Yes	0	0	0
	No	–1	–1	–1
Age at introduction of complementary food	4–6 mo	0	0	0
	All others	–1	–1	–1
First food offered child	Special foods[a]	0	0	0
	Biscuits	–1	–1	–1
Complementary food prepared separately	Yes	+1	+1	0
	No	–1	–1	0
	Sometimes	–1	0	0
Basis of decision to feed	Convenience	–1	–1	–1
	Fixed schedule	0	0	0
	On demand	0	0	0
Child assisted to eat	Yes	0	0	0
	No	–1	–1	0
Child encouraged to eat 1 more bite	Always	+1	+1	+1
	Sometimes	0	0	0
	Never	–1	–1	–1
Caretaker behavior when child refuses to eat after 1 or 2 bites	Child allowed to leave food	–1	–1	1
	Force-feed	–1	–1	–1
	Other (distract, coax, play, refusing food is not a problem)	0	0	0
Caretaker distractions while feeding child	None (only feeding child)	+1	+1	+1
	Other activities (talking, eating)	0	0	0

a. Cerelac, *dalia*, *saghodana*, *suji*, banana, *kitchree*, *firnee* are local baby foods specially prepared for the child.

was given a score of –1, a positive or acceptable practice a score of 0, and a highly desirable practice a score of +1 (**table 1**). The index was constructed by scoring key nutrient sources based on the food-frequency questionnaire and scoring optimal care and feeding practices based on WHO recommendations for optimal child growth [26]. Care and feeding practices were analyzed both as an index score and individually. To calculate the Household Food Insecurity Index, responses were scored in accordance with the USDA Food and Nutrition Service criteria [12].

For presentation of descriptive statistics, the distributions of household and child characteristics were calculated, and frequencies and percentages were reported. The means and standard deviations of quantitative variables were also calculated.

In univariate analysis, the association of stunting with each dependent variable was assessed. Variables were categorized into biologically and socially meaningful categories wherever required. For example, area of residence was categorized as urban or peri-urban. Prevalence odds ratios and 95% confidence intervals were calculated individually for each of the potential factors potentially associated with stunting.

All variables of interest with a p value < .25 on univariate analysis were considered for inclusion in reduced multivariate analysis by logistic regression. Variables that did not meet the p value criteria but had known biological or social significance were also considered while model building. The approach in building the final model was to seek out the most parsimonious model that was also biologically or socially meaningful. Before beginning multivariate analysis, correlation among the various independent variables was also checked. The model-building exercise began with the variable found most significant in the univariate analysis and continued with the subsequent addition of the next most significant variable. The final model included variables that were significant at $p \leq .10$. All data were analyzed with the Statistical Package for the Social Sciences (SPSS version 10.0, Chicago, IL, USA).

Results

A total of 447 households were approached to participate in the survey. Fourteen eligible households (3%) declined to participate for reasons not cited; thus, a total of 433 eligible households were interviewed. Anthropometric measurements for 34 children were incomplete, and the final analysis was based on 399 children.

TABLE 2. Household characteristics of 399 children between 6 and 18 months of age residing in squatter settlements in Karachi

Characteristic	Value
Water source—no. (% of children)	
Tap in house	263 (65.9)
Public tap	51 (12.8)
Tanker-truck or vendor	68 (17.0)
Well	17 (4.3)
Ethnicity—no. (% of children)	
Urdu-speaking	122 (30.6)
Baluchi	85 (21.3)
Punjabi	55 (13.8)
Pushto	53 (13.3)
Sindhi	38 (9.5)
Other (Hindko, Kashmiri, Saraiki, Bengali, Gujrati)	46 (11.7)
Household food-security status—no. (% of children)	
Food secure	232 (58.1)
Food insecure without hunger	70 (17.6)
Food insecure with hunger	97 (24.3)
No. of persons in household (mean ± SD)	8.8 ± 4.3
Monthly household income (mean ± SD)	Rs. 4,503 ± 2,640[a]

a. Based on data from 376 children. US$1 = Rs.57.5 (December 2004).

Descriptive statistics

Household characteristics

Nearly 84% of the children resided in urban squatter settlements located in congested pockets within Karachi. The remaining 16% resided in more remote locations within the city and therefore were considered periurban dwellers. All of the households had access to urban transportation and roads.

Only 34% of the children lived in permanent houses with reinforced concrete cement roofs. The rest lived in houses with temporary roofing of various forms and quality, ranging from asbestos sheets (55%) to thatched roofs (3%). On average, a household consisted of nine persons with a mean household monthly income of Rs.4,500 ± 2,600 (US$1 = Pakistan Rs.52, June 2000). There was no significant difference among the squatter settlements in reported mean monthly income, except for the periurban squatter settlement Rehri Goth, where the reported mean monthly income was approximately Rs.1,900 ± 980) (**table 2**).

Parental characteristics

The mean age was 33 years for the fathers and 27 years for the mothers. The mean duration of marriage was approximately 8 years. Thirty-five percent of the fathers had no formal education. The majority of the mothers (52%) had no formal schooling; slightly more than two-fifths of them had attended primary school (22%) or secondary school (21%).

Characteristics of the children

Nearly 53% of the children were males. The mean age was 12.1 months for boys and 12.2 months for girls. Forty-five percent of the children had been born at home, and the rest had been born in a private health facility (30%) or a government health facility (25%). Birthweight was available for only 92 children; of these, 18.5% were low-birthweight infants (< 2,500 g). Only 26% of the children had received all the appropriate vaccinations for their age (**table 3**).

Nearly all of the children (97%) had been breastfed. However, nearly 46% had also been given nonhuman milk or formula. Nearly 34% of the children had been breastfed exclusively for 4 to 6 months, and 39% had been breastfed exclusively for a shorter period. The age at which feeding with nonhuman milk or formula was initiated was 5 months on average and ranged from immediately after birth to 17 months. The mean age for introduction of complementary foods was also approximately 5 months (**table 3**).

The overall prevalence rates of stunting, wasting, and underweight were 22.1%, 9.6%, and 24%, respectively (**table 4**). Overall 12.7% of children between the age of 6–8 months were stunted, 16.7% between 9–11

TABLE 3. Characteristics of 399 children between 6 and 18 months of age residing in squatter settlements in Karachi

Characteristic	No. (%)
Age (mo)	
6–8	79 (19.8)
9–11	96 (24.1)
12–14	103 (25.8)
15–18	121 (30.3)
Male sex	212 (53.1)
Place of delivery	
Government health facility	103 (25.8)
Private health facility	118 (29.6)
Home	178 (44.6)
Birthweight[a]	
< 2,500 g (low birthweight)	17 (18.5)
> 2,500 g	75 (81.5)
Morbidity and health	
Diarrhea in past 2 wk	179 (44.9)
Ever had measles	36 (9.0)
Vaccination status	
Appropriately vaccinated for age	103 (25.8)
Partially vaccinated	291 (72.9)
Never vaccinated	5 (1.3)
Ever breastfed	388 (97.2)
Duration of exclusive breastfeeding (mo)	
Never breastfed exclusively	13 (3.3)
< 2	148 (37.1)
2 –4	122 (30.6)
4.1–6	135 (33.8)
> 6	35 (8.8)
Ever given nonhuman milk or formula	182 (45.6)
Age started nonhuman milk or formula (mo)[b]	
< 2	36 (19.8)
2 –4	55 (30.2)
4.1–6	59 (32.4)
> 6	32 (17.6)
Age initiated complementary feeding (mo)	
Not yet initiated	21 (5.3)
< 4	43 (10.8)
≥ 4	335 (84.0)

a. $n = 92$.
b. $n = 182$.

months, 24.3% between 12–14 months, and 30.6% between 15–18 months. A similar increasing trend was observed for wasting and underweight.

TABLE 4. Nutritional status[a] of 399 children between 6 and 18 months of age residing in squatter settlements in Karachi according to age group

Age group (mo)	*n*	Stunted % (no.)	Wasted % (no.)	Underweight % (no.)
6–8	79	12.7 (10)	1.3 (1)	5.1 (4)
9–11	96	16.7 (16)	8.4 (8)[b]	22.1 (21)[b]
12–14	103	24.3 (25)	8.8 (9)[c]	25.5 (26)[c]
15–18	121	30.6 (37)	16.5 (20)	36.4 (44)
6–18 (overall)	399	22.1 (88)	9.6 (38)[d]	23.9 (95)[d]

a. Stunted, wasted, and underweight are defined by height-for-age, weight-for-height, and weight-for-age < –2 z scores, respectively.
b. $n = 95$.
c. $n = 102$.
d. $n = 397$.

Univariate analysis

According to univariate analysis, household characteristics associated with stunting included household size, use of an outside water source, use of open fields for sanitation purposes, and periurban dwelling.

The variables pertaining to food insecurity in the household in the past 12 months were also found to be significantly associated with stunting (**table 5**). Among parental characteristics, factors significantly associated with an increased likelihood of the child's being stunted included having a father with no formal schooling (prevalence odds ratio, 2.1; 95% confidence interval, 1.2 to 3.7) or even primary-level schooling (prevalence odds ratio, 2.8; 95% confidence interval, 1.4 to 5.4). Having a mother with no formal schooling was also associated with stunting in her child (prevalence odds ratio, 3.2; 95% confidence interval, 1.6 to 6.2). (**table 6**)

According to univariate analysis, girls were more likely to be stunted than boys (prevalence odds ratio, 2.4; 95% confidence interval, 1.5 to 3.9). Furthermore, we found no significant difference in the age distribution of boys and girls in our study, confirming that differences in stunting between boys and girls were not due to age distribution in the sample.

Child-care and feeding practices associated with stunting included feeding the child family foods (prevalence odds ratio, 2.1; 95% confidence interval, 1.1 to 4.1) and feeding of the child by a sibling (prevalence odds ratio, 2.6; 95% confidence interval, 1.2 to 5.9). Other factors associated included the mother's perception that complementary foods need not be specially prepared (prevalence odds ratio, 2.0; 95% confidence interval, 1.0 to 4.0) and the mother's self-reported involvement in other activities or interactions while feeding the child (prevalence odds ratio, 1.6; 95% confidence interval, 1.0 to 2.6) (**table 7**).

Finally, analysis of the Complementary Feeding Care Index scores indicated that there were statistically sig-

TABLE 5A. Distribution of responses to household food insecurity module items reported by mothers of 399 children between 6 and 18 months of age residing in squatter settlements in Karachi

Item[a]	No. (%)	Item[a]	No. (%)
Best description of food eaten in the household in past 12 mo		How often did an adult family member skip or reduce a meal because of insufficient finances? (n = 101)	
Enough to eat and the kind we want	162 (40.6)	Almost every month	40 (39.6)
Enough, but not always the kind we want	152 (38.1)	Some months but not every month	41 (40.6)
Sometimes not enough	68 (17)	1 or 2 months only	20 (19.8)
Often not enough	17 (4.3)		
Worried that food would run out before we have money to buy more		Have you ever eaten less than you felt you should have because of insufficient finances?	
Never	225 (56.4)	No	294 (73.7)
Sometimes	62 (15.5)	Yes	100 (25.1)
Often	110 (27.6)	Don't know or no response	5 (1.3)
Don't know or no response	2 (0.5)		
Food didn't last and we didn't have money to buy more		Has any child in the household skipped or reduced a meal because of insufficient finances?	
Never	242 (60.7)	No	332 (83.2)
Sometimes	57 (14.3)	Yes	66 (16.5)
Often	98 (24.6)	Don't know or no response	1 (0.3)
Don't know or no response	2 (0.5)		
Couldn't afford to eat a balanced meal		How often did a child in the household skip or reduce a meal because of insufficient finances? (n = 66)	
Never	188 (47.1)	Almost every month	32 (48.5)
Sometimes	97 (24.3)	Some months but not every month	19 (22.7)
Often	96 (24.1)	1 or 2 months only	15 (22.7)
Don't know or no response	18 (4.5)		
Has any adult family member skipped or reduced a meal because of insufficient finances?			
No	296 (74.2)		
Yes	101 (25.3)		
Don't know or no response	3 (0.6)		

a. All questions are with reference to the last 12 months.

nificant differences in mean scores for complementary feeding practices but not for breastfeeding practices. Also, among the individual components of complementary feeding, the mean intake of tea per week was also higher in stunted children (**table 8**).

Multivariate analysis

The final results of our study, after adjustment for the potential confounding effects of age, indicated that female sex (adjusted prevalence odds ratio, 2.8; 95% confidence interval, 1.6 to 4.7) and household food insecurity with hunger in the past 12 months (adjusted prevalence odds ratio, 2.9; 95% confidence interval, 1.6 to 4.9) were strongly associated with stunting. Among sociodemographic and parental characteristics, having a mother with no formal schooling (adjusted prevalence odds ratio, 2.9; 95% confidence interval, 1.4 to 3.8) was also significantly associated with stunting. Stunted children were also more likely to live in crowded households (adjusted prevalence odds ratio, 1.7; 95% confidence interval, 1.0 to 3.8) (**table 9**).

Discussion

The prevalence of stunting in our survey increased with age, similar to patterns reported from other developing countries [27]. Pakistan's National Nutrition Survey 2001–2002 [28] reported a prevalence of stunting of nearly 24% among children between the ages of 6 and 23 months; this was slightly higher than the value we found, but the difference was understandable since we studied a younger age group (6 to 18 months).

Certain care and feeding practices, such as the child's eating family foods instead of transitional foods or being fed by a sibling, showed associations with stunting at the univariate level, but these associations disappeared in the multivariate analysis. Female sex was significantly associated with stunting after the child's age, area of residence, maternal education, and household food security had been controlled for. This finding was consistent with health statistics that indicate gender discrimination in South Asia [29] and the strong preference for sons in Pakistani society [30, 31]. Although gender inequalities in health have been

TABLE 5B. Univariate analysis of household food insecurity module items associated with stunting in children residing in squatter settlements in Karachi [a]

Item	Stunted (n = 88)	Not stunted (n = 311)	Prevalence OR	95% CI
	no. (%)			
Mother eats less than desired because of insufficient finances				
Yes	38 (43.2)	63 (20.3)	3.0*	1.8–4.9
No	50 (56.8)	248 (79.7)	1	
Any child in household skips or reduces meals because of insufficient finances				
Yes	29 (33.0)	37 (11.9)	3.6*	2.1–6.4
No	59 (67.0)	274 (88.1)	1	
Any family member skips or reduces meals because of insufficient finances				
Yes	39 (44.3)	62 (19.9)	3.2*	1.9–5.3
No	49 (55.7)	249 (80.1)	1	
Household food insecurity				
Food insecure with hunger	37 (42.0)	60 (19.3)	2.9*	1.6–4.9
Food insecure without hunger	14 (15.9)	56 (18.0)	1.3	0.6–2.6
Food secure	37 (42.0)	195 (62.7)	1	

OR, odds ratio; CI, confidence interval
* $p < .001$
a. Not all items are shown.

TABLE 6. Univariate analysis of parental characteristics associated with stunting in children residing in squatter settlements in Karachi

Characteristic	Stunted (n = 88)	Not stunted (n = 311)	Prevalence OR	95% CI
	no. (%)			
Father's education (yr)				
0	38 (43.2)	102 (32.8)	2.1*	1.2–3.7
1–5	21 (23.9)	43 (13.8)	2.8*	1.4–5.4
> 5	29 (33.0)	166 (53.4)	1	
Mother's education (yr)				
0	60 (68.2)	146 (46.9)	3.2*	1.6–6.2
1–5	16 (18.2)	72 (23.2)	1.7	0.8–3.9
> 5	12 (13.6)	93 (29.9)	1	
Mother's body-mass index[a]				
Overweight	16 (20.8)	86 (29.3)	0.7	0.3–1.4
Underweight	24 (31.2)	61 (20.7)	1.6	0.9–2.8
Normal	37 (48.1)	147 (50.0)	1	

OR, odds ratio; CI, confidence interval
* $p < .001$
a. n = 290 among nonstunted (nonpregnant women); n = 77 among stunted.

reported from other South Asian countries [29, 32, 33], they have not been highlighted in recent studies from Pakistan. The Pakistan Family and Fertility Planning Survey [30] reported a continued preference for sons; 48% of married women wanted their next child to be a boy, but only 9% wanted a girl.

It is well documented that in South Asia gender preference is mainly manifested as excessive mortality of female children due to discrimination in food allocation and health care within the household [34, 35]. In 1996/97 the under-five mortality rate for children in Pakistan was higher for girls than for boys (23 and 18 per 1,000, respectively) [30], and there was a significant imbalance in the female-to-male ratio for all ages under 45 years. For every 100 girls there were 112 boys, the inverse of what is usually seen in developed countries for this age group [29]. Thus, factors that were observed to be associated with malnutrition in the broader category of children under five years of age in national studies may be biased toward those who survived.

The survey confirmed that in Karachi's urban slums, both the father's education and the mother's education are assets for the growth of a child. Maternal education has been consistently shown to be critically important for a child's health, nutrition, and survival. Although the precise mechanism by which maternal education affects child outcomes is not fully understood, evidence from various countries indicates that knowledge and practices are key pathways. Educated women are likely to be more aware of nutrition, hygiene, and health care [29]. Notably, an African study found that recovery from stunting had a stronger association

TABLE 7. Univariate analysis indicating feeding and child care practices associated with stunting in children residing in squatter settlements in Karachi

Practice	Stunted ($n = 88$)	Not stunted ($n = 311$)	Prevalence OR	95% CI
	no. (%)			
Complementary feeding initiated				
Yes	87 (98.9)	296 (95.2)	4.4	0.6–33.8
No	1 (1.1)	15 (4.8)	1	
Age complementary feeding initiated (mo)				
Not yet initiated	2 (2.3)	19 (6.1)	0.4	0.1–1.7
< 4	13 (14.8)	30 (9.6)	1.6	0.8–3.1
≥ 4	73 (83.0)	262 (84.2)	1	
Child eats family foods[a]				
Yes	74 (85.1)	215 (72.6)	2.1*	1.1–4.1
No	13 (14.9)	81 (27.4)	1	
Child most often eats family foods[a]				
Yes	66 (75.9)	187 (63.2)	1.8*	1.1–3.2
No	21 (24.1)	109 (36.8)	1	
Child fed by sibling[a]				
Yes	11 (12.5)	16 (5.1)	2.6*	1.2–5.9
No	77 (87.5)	295 (94.9)	1	
Mother's activity during feeding session[a]				
Performing other activities or interactions	41 (47.1)	107 (36.1)	1.6	1.0–2.6
Concentrating only on child	46 (52.9)	189 (63.9)	1	
Mother's opinion as to whether complementary foods should be especially prepared				
Need not be	14 (15.9)	27 (8.7)	2.0	1.0–4.0
Should be	74 (84.1)	284 (91.3)	1	

OR, odds ratio; CI, confidence interval
* $p < .05$
a. $n = 296$ among nonstunted; $n = 87$ among stunted.

with the mother's education than with household income [36].

Evidence from several developing countries shows that the under-five mortality rate declines with each additional level of education of the mother [30, 37]. For example, Bangladesh managed to increase its female literacy rate from 17% in 1980 to 48% in 2000 and to reduce the under-five mortality rate from 144 per 1,000 live births in 1990 to 89 per 1,000 live births in 1999 [37].

Pakistan still has one of the lowest female literacy rates in South Asia (33%) [38]. According to the National Health Survey of Pakistan, the prevalence of stunting among children under five was nearly 40% in households where all of the adult women were illiterate, but it decreased to 25% when at least one adult woman had completed at least 10 years of schooling [39]. Edu-

TABLE 8. Univariate analysis indicating Complementary Feeding Care Index (CFCI) associated with stunting in children residing in squatter settlements in Karachi[a]

Variable	Stunted ($n = 88$)	Not stunted ($n = 311$)	Prevalence OR	95% CI
Tea intake				
Tea given—no. (%)	73 (83.0)	205 (65.9)	2.5*	1.4–4.6
Tea never given—no. (%)	15 (17.0)	106 (34.1)	1	
				p value
Tea intake per week (days)[a]	5.5 ± 2.8	4.1 ± 3.5		.001
Nutrient intake CFCI				
Vitamin C CFCI score	0.3 ± 0.7	0.2 ± 0.7		.2
Iron/folic acid CFCI score	0.7 ± 0.7	0.5 ± 0.8		.03
Vitamin A CFCI score	0.77 ± 0.5	0.76 ± 0.5		.8
Tea CFCI score	–0.8 ± 0.4	–0.66 ± 0.5		.002
Practices CFCI				
Breastfeeding practices CFCI score	0.25 ± 0.9	0.45 ± 1.0		.10
Complementary feeding practices score	–0.5 ± 1.8	0.04 ± 1.8		.013
Overall CFCI score	0.68 ± 2.6	1.25 ± 2.6		.012

OR, odds ratio; CI, confidence interval
a. Plus–minus values are means ± SD.
* $p < .05$

cation for girls is considered one of the best strategies for breaking the cycle of ignorance and exploitation and empowering women and girls to improve their lives and those of their offspring [29, 40].

In the final multivariate model, household food insecurity with the presence of hunger was associated with stunting. The prevalence of food insecurity with hunger in our study (24.3%) was much lower than that reported in studies conducted in India (57.4%) [20] and Uganda (58.3%) [20] using a modified USDA food security core module. The higher prevalence in the Indian study could be due to the fact that their sample was drawn from a very economically vulnerable population for the purpose of studying child labor and thus was not representative of the urban poor in general.

TABLE 9. Factors associated with stunting in 399 children residing in squatter settlements in Karachi based on the final multivariate logistic regression model

Variable	Stunted ($n = 88$)	Not stunted ($n = 311$)	Adjusted prevalence OR	95% CI
	no. (%)			
Household size				
> 6	66 (75.0)	195 (62.7)	1.7*	1.0–3.8
≤ 6	22 (25.0)	116 (37.3)	1	
Household food insecurity				
Food insecure with hunger	37 (42.0)	60 (19.3)	2.9**	1.6–4.9
Food insecure without hunger	14 (15.9)	56 (18.0)	1.3	0.6–2.6
Food secure	37 (42.0)	195 (62.7)	1	
Child's sex				
Female	56 (63.6)	131 (42.1)	2.8**	1.6–4.7
Male	32 (36.4)	180 (57.9)	1	
Mother's education (yr)				
0	60 (68.2)	146 (46.9)	2. 9**	1.4–3.8
1–5	16 (18.2)	73 (23.5)	1.6	0.7–3.8
> 5	12 (13.6)	92 (29.6)	1	
Child's age (mo)				
15–18	37 (42.0)	84 (27.0)	3.1*	1.4–6.9
12–14	25 (28.4)	78 (25.1)	2.1	0.9–5.0
9–11	16 (18.2)	80 (25.7)	1.2	0.5–2.9
6–8	10 (11.4)	69 (22.2)	1	

OR, odds ratio; CI, confidence interval
*$p < .05$; **$p < .001$

In urban areas, households buy most of their food, and therefore a lack of income compounded by large family size can grossly challenge food security. The poor are generally more vulnerable to fluctuations in food prices than the well-off. However, among the urban poor, poverty is due primarily not to lack of work but to the lack of well-paying, steady jobs [41]. Nearly 6% of the fathers in our survey were unemployed, and the rest worked at jobs such as street vendor, shopkeeper, fisherman, domestic worker, sanitation worker, and so forth.

For several decades, WHO has issued recommendations regarding the appropriate age to begin complementary feeding, which have varied from "infants to be exclusively breastfed during the first four to six months of life" to the recent resolution of "fostering appropriate complementary feeding practices from about six months with emphasis on continued breastfeeding and frequent feeding with safe and adequate amounts of local foods" [26]. Even though specific feeding practices do not appear in our final adjusted model, the role of care and feeding practices and the WHO recommendations on complementary feeding and breastfeeding practices, especially in households where there is food insecurity, needs to be reassessed. Clearly, a household that faces food insecurity has a greater burden when deciding how to ensure their growing child has a nutrient-dense and appropriate diet. The situation is exacerbated by the introduction of inappropriate complementary foods and a reliance on nonhuman milk or formula, which may be contaminated or of poor nutritional quality.

In our study, even though 97% of the mothers had practiced exclusive breastfeeding and nearly 34% had exclusively breastfed their child for at least 4 to 6 months, almost half (45%) had used nonhuman milk or formula as well. Among the children given supplemental nonhuman milk, nearly half received the supplemental milk or formula by the age of 4 months. Surveys among the general population by advocacy groups suggest that bottle-feeding has become an acceptable practice, with mothers unnecessarily supplementing their own milk with nonhuman milk or formula after being convinced that they are "unable" to breastfeed their children [42]. This trend is particularly dangerous in an environment where basic hygiene is compromised.

A disparity was observed between the perceptions and the practices of the mothers in our study. Nearly 90% of the mothers reported that complementary foods should be specially prepared for children in this

age group, but nearly 63% were reportedly feeding their children predominantly with family foods. This situation was highlighted by the fact that children given family foods were more likely to be stunted. Clearly, country- or even region-specific feeding guidelines need to be formulated to help families identify cheap, easily accessible, and appropriate home foods for their children.

Limitations of the study

In the past few years, the World Health Organization (WHO) has raised concerns regarding the appropriateness of using the NCHS reference standards internationally, because this reference was compiled from a dataset based on a sample of infants from a single North American community who were predominantly bottle-fed [43, 44]. For lack of a more appropriate reference standard, as well as to allow global comparisons, the NCHS reference was used to define the outcome variable in this study.

Furthermore, care and feeding are better measured by making observations in households and performing longitudinal studies that can capture the timing and nature of changes and transitions, as well as morbidity incidences [45]. Since this was a cross-sectional survey, the study design did not allow for any comments on causal inference. Also, information was gathered only from the mothers.

The USDA food security core module has not been validated according to the guidelines suggested by Frongillo and coworkers [46, 47] in Pakistan. However, in India and Uganda, reasonably reliable scales have been constructed from this module by essentially just translating the questions and conducting modest amounts of cognitive testing [20]. Similar difficulties as we have reported in understanding the word "balanced" have been reported in other populations, and adaptations have been made [16, 17] without losing the content and face validity of the original.

Stunting is a cumulative process that starts in utero, and there is substantial evidence that intrauterine growth is a strong predictor of postnatal growth. Low birthweight (< 2,500 g) is associated with stunting [27, 48]. In Pakistan, it is estimated that nearly 19% of infants are born with low birthweight [49]. We obtained similar findings for the 92 children in our study for whom birthweight was documented. However, since nearly 77% of the children in our study had not been weighed at birth, birthweight was a factor whose effect could not be controlled for, and thus a potential exists for some residual confounding.

Recommendations

Education and poverty, as assessed by household indicators, have an impact on each other and consequently on the health of children. In order to break the cycle of malnutrition, investment in basic services, such as primary education, particularly of girls, is essential, along with clear guidelines for the community regarding cheap, easily available, and appropriate home foods for their young children.

However, for poorer households where food insecurity exists, knowledge of care and feeding practices may not be sufficient, and other types of interventions, such as food stamps or food supplementation, must precede or accompany educational efforts if an impact on child health and nutrition is to be expected. Further follow-up work needs to be done in urban settlements in Pakistan in order to understand the role of gender inequality and the dynamics of food distribution within the household and to provide formal validation for this population in Pakistan of an instrument measuring the phenomenon of household food insecurity and hunger in the presence of financial constraints.

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Women's empowerment and domestic violence: The role of sociocultural determinants in maternal and child undernutrition in tribal and rural communities in South India

Kavita Sethuraman, Richard Lansdown, and Keith Sullivan

Abstract

Background. *Moderate malnutrition continues to affect 46% of children under five years of age and 47% of rural women in India. Women's lack of empowerment is believed to be an important factor in the persistent prevalence of malnutrition. In India, women's empowerment often varies by community, with tribes sometimes being the most progressive.*

Objective. *To explore the relationship between women's empowerment, maternal nutritional status, and the nutritional status of their children aged 6 to 24 months in rural and tribal communities.*

Methods. *This study in rural Karnataka, India, included tribal and rural subjects and used both qualitative and quantitative methods of data collection. Structured interviews with mothers were performed and anthropometric measurements were obtained for 820 mother–child pairs. The data were analyzed by multivariate and logistic regression.*

Results. *Some degree of malnutrition was seen in 83.5% of children and 72.4% of mothers in the sample. Biological variables explained most of the variance in nutritional status, followed by health-care seeking and women's empowerment variables; socioeconomic variables explained the least amount of variance. Women's empowerment variables were significantly associated with child nutrition and explained 5.6% of the variance in the sample. Maternal experience of psychological abuse and sexual coercion increased the risk of malnutrition in mothers and children. Domestic violence was experienced by 34% of mothers in the sample.*

Conclusions. *In addition to the known investments needed to reduce malnutrition, improving women's nutrition, promoting gender equality, empowering women, and ending violence against women could further reduce the prevalence of malnutrition in this segment of the Indian population.*

Key words: Child nutrition, domestic violence, maternal nutrition, nutritional status, women's empowerment

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Introduction

Childhood malnutrition remains highly prevalent in India; 46% of all children under five years of age are stunted [1]. The far-reaching consequences of childhood malnutrition are well established [2–4]. Progress in reducing the prevalence of malnutrition in India has been steady but slow [5, 6]. Overall, investment in nutrition has been inadequate [5]. Program efforts to tackle malnutrition have focused on the provision of services, but these have been plagued with operational setbacks and have often not integrated community participation [5]. The direct causes of childhood malnutrition are inadequate dietary intake, disease, and inadequate care practices [7]. In India, however, the prevalence of low birthweight is 23%, and is not only a consequence of maternal malnutrition but also contributes significantly to subsequent child malnutrition [1, 7–9]. Maternal malnutrition in India, measured by chronic energy deficiency, defined as a body-mass index (BMI) < 18.5 kg/m^2, affects 47% of rural women [1]. Recent studies have found that maternal nutritional status is significantly associated with the nutritional status of young children, not just of neonates [10]. Additionally, the effects of maternal malnutrition, low birthweight, and childhood malnutrition are compounded by the practice of early marriage, which leads to early and frequent pregnancies [11, 12]. Underlying factors that most likely contribute to malnutrition

through sociocultural pathways are gender inequity and women's lack of empowerment [9, 13].

Women's empowerment

The extent to which empowering women in this region can bring about improvements in nutrition outcome is yet to be explored. Measuring women's empowerment is challenging, because the term itself is often poorly defined [14–16]. The key underlying concepts that define women's empowerment relate to choices, control, and power [17]. Women's empowerment is conceptualized as a function of women's access to and control over resources, which extends to their decision-making capabilities regarding household decisions, employment, income, household assets and expenditure, fertility, sexuality, and freedom of movement (physical mobility) and their control over material and intangible resources such as information and time; their position within the household vis-à-vis other male and female household members; their experience of domestic violence; and their education [14, 18]. For most women in South Asia, gaining control over resources, in addition to gaining access to resources, is essential [14].

Women's empowerment and child health

Several studies have looked for associations between indicators of women's empowerment and child health outcomes [19–33]. The increase in women's education from 1970 to 1995 is one indicator of women's empowerment that has contributed to a reduction of more than 50% in the prevalence of underweight [23]. Studies have found that secondary education for women confers the greatest benefit and that education is most beneficial to mothers when they also have moderate access to resources and wealth [22, 34]. The association between maternal employment and child health outcomes is inconsistent. Two studies found that among poor women who worked as daily wage laborers, maternal employment significantly increased the risks of child mortality and malnutrition [24, 25]. Qualitative research from India found that because women's wages are so low compared to men's, families prefer that women stay home where their efforts would be more productive for the household [35]. However, studies also show that mothers who contribute more to total household income are less likely to have malnourished children and that the majority of mothers' incomes are used to provide for their children [26, 27]. A meta-analysis of Demographic and Health Survey data from 36 developing countries found that some indicators of women's empowerment, such as the mother's age at marriage, had a significant positive association with children's nutritional status [28]. In a longitudinal study of slum children in Mumbai, India, poor growth in children was found to be significantly associated with illiteracy, experience of marital disharmony, younger age at marriage, and less decision-making power among mothers [29].

Domestic violence and child health

Several recent studies have also found that maternal experience of physical and sexual violence is significantly associated with an increased risk of under-five mortality, infant and fetal death, and low birthweight [30–33]. Recent surveys have found that the prevalence of domestic violence (defined as physical beating or battering of a woman by a male intimate partner) ranges from 22% to 60% [36, 37]. The prevalence of psychological and emotional abuse (defined as a woman's being threatened with physical abuse, ridiculed, or ignored) is believed to be even higher [36, 37]. The precursors of domestic violence are marital conflict, male control over household wealth and decision-making, poverty, and unemployment [38]. The high prevalence of domestic violence and its impact on child health and survival make it critical to also understand its impact on child nutrition.

Women's empowerment in tribal and rural communities in India

Some tribal communities in India have social norms that enable their women to be more empowered than their nontribal rural counterparts [39, 40]. For example, in these communities women are more involved in decision-making, have greater freedom of movement, are free to choose their marital partners, and can divorce and remarry without stigma [39, 40]. Our study explored the relationship between women's empowerment, maternal nutritional status, and the nutritional status of their children 6 to 24 months of age in tribal and rural communities in South India. We present some qualitative findings and an analysis of cross-sectional data on children's weight-for-age and maternal weight and BMI.

Subjects and methods

Study population

This study was undertaken in the Mysore region of Karnataka, India (a rural region), between November 1998 and August 2000. The first phase used qualitative methods, and the second quantitative. The study population included the scheduled caste, backward caste, and one scheduled tribe. To obtain a sample in which the level of empowerment differed among women, the Soliga tribe and a neighboring rural community were selected. This tribe was selected because it was known

to have social norms conducive to empowering women, whereas the opposite was true for women in the rural communities [40]. The Soliga tribe lived in the forested areas of southern Karnataka, and the neighboring rural community included scheduled and backward caste families. The distance to the nearest major town or city was more than 20 km for the tribal community and 5 to 8 km for the rural villages. Originally, access to this tribe and the neighboring rural population was obtained through Vivekananda Girijana Kalyana Kendra (VGKK), a local nongovernmental organization that has served this population in an area known as the BR Hills (Biligiri Renganna Betta Hills) since the 1970s.

Survey design

Qualitative research was undertaken primarily to inform the design of the questionnaire, verify the relevance of the conceptual framework to these communities, and confirm differences between the tribal and the rural women in terms of empowerment. A conceptual framework for women's empowerment specific to the South Asian context was adapted from the literature [14, 16, 18, 41]. The study participants were asked a range of questions related to women's empowerment, such as their impressions of women's involvement in household decision-making. The main methods of qualitative data collection were semistructured interviews with women of childbearing age (15 to 49 years) and focus-group discussions among same-sexed groups. A total of 148 semistructured interviews, 19 focus-group discussions with women, and 11 focus-group discussions with men were completed; the number of participants per focus-group discussion ranged from 6 to 12. The qualitative data were coded and analyzed manually.

The questionnaire was developed from these data and from review of the literature and relevant survey tools [1, 14, 41]. The overall design of the questionnaire and the format of the close-ended questions followed Babbie's [42] guidelines. The questionnaire was translated into the local language, Kannada, back-translated to ensure accuracy of content and semantic and conceptual equivalence, and then pretested. The interviewers were trained, and reliability tests were performed to ensure consistency in the methods of asking questions and recording answers. The questionnaire was field-tested and piloted on a randomly selected subsample of respondents. A local calendar was developed to obtain children's birth dates, and a letter was drafted to obtain oral informed consent. To meet the ethical guidelines on researching domestic violence, a counsellor was hired at this time and was available to the interviewers and respondents at all times for the duration of the study [43]. Every effort was made to ensure the respondents' privacy and maintain confidentiality during interviews. With a few exceptions, such as when a community center was not available, all the interviews were conducted in the *anganwadi* centers (child-feeding centers of the national Integrated Child Development Scheme). If other family members accompanied the women, they were asked to remain outside the centers; the counsellor played the role of gatekeeper at this time.

Anthropometry

Children 6 to 24 months of age were enrolled in the study. Children's weight was measured to the nearest 0.1 kg with a Salter scale (CMS Weighing Equipment, London, UK) and recumbent length to the nearest 0.5 cm with a Starter mat (Starters, Norwich, UK). Maternal weight was measured to the nearest 0.1 kg with a digital adult scale (THD 305, CMS Weighing Equipment) and maternal height to the nearest 0.1 cm with a portable stadiometer (Leicester Portable Measure, Leicester, UK). Maternal and child hemoglobin was measured in a fingerprick sample with a HemoCue (HemoCue, Sheffield, UK). All measurements were performed by the first author.

Ethical approval for this study was obtained from Vivekananda Girijana Kalyana Kendra (VGKK), the local nongovernmental organization in BR Hills, and the Institute for Child Health/Great Ormond Street Hospital, London.

Sampling methods

Sample size calculations were based on a difference of 11% in height-for-age between the tribal and rural children at 80% power and 5% significance level according to the findings of the previous National Family Health Survey survey of Karnataka undertaken in 1992/93 [44]. The final sample size was 406 for the tribal cell and 406 for the rural cell. Measurements and interviews were completed on 405 rural and 415 tribal mother–child pairs. The responses were recorded by the interviewers on paper questionnaires. A random cluster sample was drawn for the rural villages, including the villages for the pilot study. Seven villages were randomly selected, and all the children and mothers from the scheduled and backward caste neighborhoods within them were enrolled in the study; five eligible participants declined to participate. For the tribal mothers and children, the total population of the Soliga tribe in the state of Karnataka was 25,000, and a census sample was used to obtain adequate numbers of children for this cell; two eligible participants declined to participate. Only one eligible child per household was included in the sample. An oral invitation to participate in the study was extended to eligible subjects. Oral informed consent was obtained from the mothers for themselves and on behalf of their children.

Statistical methods

The questionnaires were double-entered into a template created in Epi Info version 6 (Centers for Disease Control and Prevention, Atlanta, GA, USA). The data were extracted, verified, and cleaned. The anthropometric data were converted into z scores based on the NCHS (National Center for Health Statistics) reference standards. The subsequent statistical analysis was performed with the statistical package SPSS, version 11 (SPSS, Chicago, IL, USA). Basic descriptive analysis, factor analysis, and bivariate analyses were performed on the data set. Both multivariate linear stepwise regression and multivariate forward conditional logistic regression were performed. The biological variables, such as hemoglobin, maternal height, maternal weight, and maternal BMI, were entered as actual values. The independent variables were grouped into four categories for analysis. The first consisted of only the biological variables, including maternal height or weight, children's hemoglobin, children's dietary intake, children's morbidity, and children's immunizations. The second set consisted of the nutrition and health variables, including health-care seeking, food security, child feeding, and maternal reproductive health. The third set consisted of the women's empowerment variables, including the mother's decision-making capabilities, freedom of movement, employment, and experience of domestic violence. The fourth set consisted of all the socioeconomic variables, including education. All of the significant variables from the previous four regressions were then included in a final regression analysis.

BOX 1. Selected responses on various themes in the qualitative survey

Rural Community	Tribal Community
Women's employment	
"I work as an agricultural wage laborer. They pay me 13 rupees a day. I would prefer to stay home, but I have no choice. It's a luxury to stay home, so I have to work outside." *Interviewee, 25 years old, no formal schooling*	"I don't like to work outside the home. I do fieldwork. I like my fieldwork. I don't want to work as a daily wage laborer." *Interviewee, 46 years old, no schooling*
"If we want to work anywhere or change jobs, we have to get our husbands' permission. Once we are a part of a household, we have to ask for such things." *Women's focus-group discussion*	"We like our fieldwork; we don't want to work on other people's land." *Women's focus-group discussion*
"Many women stay home. They are not interested in working as coolies (daily wage laborers). Only those who are very poor work as coolies, because they have no option." *Women's focus-group discussion*	
Control of household finances	
"Here, I need my husband's permission to get a loan. If he says OK, you can get a loan, then I can get a loan from another woman. Women can only get loans from other women." *Interviewee, 22 years old, no formal schooling*	"When I don't have any money I get credit and buy the necessary supplies for the house. When I get some 10 to 20 rupees or so from my husband, or by selling something, or after I have worked and earned it back, then I pay back the money I owe." *Interviewee, 35 years old, 4 years of formal schooling*
"We give what we earn to our husbands—we hand over everything, we can't keep any. They ask us why we are saving it, who are we saving it for. So we can't keep anything, we hand it all over to the men. When men get money, some will give us a little, but most men keep their money. We women buy the supplies when men give us money." *Women's focus-group discussion*	"Some men keep the money they earn and buy the household supplies, others give the money to their wives to manage. Women manage money so much better—so women deal with it, the men would spend it all. If we have 10 rupees we save it, the men would spend that 10 rupees…. Either the men or the women buy the household supplies" *Women's focus-group discussion*
Choice in marriage	
"The elders sit, discuss, and decide upon a marriage. They want the consent of the boy and girl, but the marriage is agreed upon by the family, the parents have to do it." *Women's focus-group discussion*	"The boy and girl have to agree and want to marry each other, and then they go to the forest and return. Those who can afford it may celebrate this; others just go to the forest." *Women's focus-group discussion*

Results

Qualitative findings

Analysis of the qualitative data revealed that the tribal and rural women were similar in terms of socioeconomic status, access to basic resources, and dietary practices. Tribal and rural men also had similar social roles across both groups. However, in terms of women's empowerment, tribal women differed in important ways from rural women. At the outset, all of the themes being explored were given an equal weight. Analysis of the data did, however, reveal some interesting patterns; selected responses from participants are given in **box 1**.

Nuclear families tended to predominate in tribal communities, whereas joint families were more common among the rural communities. Tribal women were traditionally the primary subsistence farmers because men often migrated for work; thus, these women stated that they preferred to work on their own land (**box 1**). Rural women, however, were not the primary subsistence farmers; those who were allowed to work and could find work did so as daily agricultural wage laborers (**box 1**). Overall, women had fewer choices than men in type of employment;

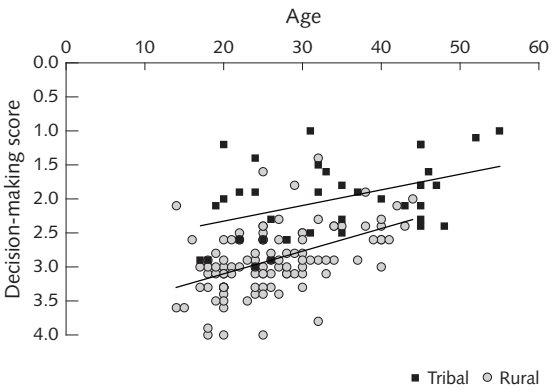

FIG. 1. Women's decision-making capabilities according to age(data from semi-structured interviews, $n = 148$). Scoring: 1 = wife decides, 2 = joint decision, 3 = husband decides, 4 = elders decide. Each decision was assigned a score based on the respondent's answer, and the total of these scores was divided by the number of decisions made, resulting in a score ranging from 1 to 4; the closer the score to 1, the greater a woman's decision-making capability

BOX 1. Selected responses on various themes in the qualitative survey *(continued)*

Rural Community	Tribal Community
Health care	
"Women can't go to the health center; in our houses women don't have permission to do that. They get in trouble; he (the husband) may ask, Why did you borrow money when I was not there? Why did you go when I was not there? She will get in trouble. For this reason she can't go until he comes. This depends on the family." *Men's focus-group discussion*	"No one decides when we should go to the health center; we just go when our children are sick. Can we wait for the men if they are not around? So we just go." *Women's focus-group discussion*
Choice of number of children	
"My husband and my parents-in-law decided on the number of children I should have." *Interviewee, 25 years old, 1 year of formal schooling*	"I decided that this many children were enough and had a tubectomy." *Interviewee, 35 years old, no formal schooling*
Freedom of movement	
"Here the men scold us if we go alone and ask us why we are going alone?" *Women's focus-group discussion*	"They have no fear. They are brave and they don't really need permission. They go quite far. There are no problems on their way; no one troubles them on the way." *Men's focus-group discussion*
Domestic violence	
"We always have fights, problems, and beatings. This is always there, it is normal. What can we do? Run away? Do we leave them then? We have to stay. We have to stay with the men whether they beat us or scold us. We have to stay—what else can we do?" *Women's focus-group discussion*	"Communally we are against violence, men do trouble their wives, but people react to beatings in a house…they get involved and say it is wrong, not acceptable and not right…they ask why are you hitting her, and they fight for her." *Women's focus-group discussion*
"No one gets involved when there is violence. No one says anything." *Women's focus-group discussion*	

they tended to work fewer days than men; and their wages were significantly lower than men's. Those who worked for wages had no choice, and they tended to come from poorer households that depended on their meager wages.

Tribal women customarily had greater decision-making power from a younger age, and overall decision-making power increased with age for both the tribal and the rural women (**fig. 1**). Tribal women had more control over household finances and were at liberty to obtain credit or borrow money from whomever they chose if needed (**box 1**). Rural women,

TABLE 1. Child and maternal characteristics in the sample

Characteristic	Tribal (n = 415)	Rural (n = 405)	Entire sample (n = 820)
Child characteristics			
WAZ	–2.2 ± 1.0	–1.8 ± 1.0	–2.0 ± 1.0
HAZ	–1.4 ± 1.0	–1.2 ± 1.0	–1.3 ± 1.0
WHZ	–1.7 ± 1.1	–1.4 ± 1.0	–1.6 ± 1.1
Hemoglobin (g/dl)	9.3 ± 1.3	9.4 ± 1.6	9.4 ± 1.5
Age (mo)	13.8 ± 6.0	15.2 ± 5.9	14.5 ± 6.0
Maternal characteristics			
Height (cm)	151.9 ± 5.5	151.8 ± 5.0	151.85 ± 5.2
Weight (kg)	40.2 ± 4.8	42.0 ± 5.7	41.1 ± 5.3
Hemoglobin (g/dl)	11.0 ± 2.0	11.8 ± 1.8	11.4 ± 1.9
BMI (kg/m^2)	17.4 ± 1.7	18.2 ± 2.2	17.8 ± 2.0
Age (yr)	21.8 ± 4.7	21.5 ± 3.9	21.7 ± 4.3
Age at marriage (yr)	15.0 ± 2.6	15.1 ± 2.9	15.1 ± 2.8
Years married	6.8 ± 4.4	6.4 ± 3.7	6.6 ± 4.1
No. of pregnancies	2.36 ± 1.3	2.14 ± 1.0	2.3 ± 1.2
Age at birth of 1st child (yr)	16.8 ± 2.6	16.9 ± 2.8	16.8 ± 2.7
No. of living children	2.2 ± 1.2	2.0 ± 1.0	2.13 ± 1.1
Education (yr)	1.3 ± 2.4	4.0 ± 4.3	2.62 ± 3.7
Child anthropometry: percentage of children below z score cutoffs[a] (n = 820)			
WAZ			
< -1	87.7	79.3	83.5
< -2	61.7	45.4	53.7
< -3	21.7	11.6	16.7
HAZ			
< -1	63.6	51.6	57.7
< -2	27.2	22.2	24.7
< -3	5.3	5.2	5.2
WHZ			
< -1	75.9	67.9	72.0
< -2	43.2	30.7	36.9
< -3	9.9	3.5	6.7
Maternal BMI: percentage of nonpregnant mothers below grade of chronic energy deficiency			
	n = 389	n = 358	n = 747
Normal (18.50)	20.1	35.8	27.6
Grade I (17.00–18.49)	33.9	28.8	72.4
Grade II (16.01–16.99)	25.4	20.4	40.9
Grade III (<16.00)	20.6	15.1	17.9

BMI, body mass index; HAZ, height-for-age z score; WAZ, weight-for-age z score; WHZ, weight-for-height z score

a. Z-score cutoffs: < –1 = mild malnutrition; < –2 = moderate malnutrition; < –3 = severe malnutrition (Based on NCHS reference standards.)

however, were not as involved in household finances and they were rarely permitted to obtain credit (**box 1**). Decision-making clearly differed between tribal and rural women. Three domains of decision-making are illustrated in **box 1**, which involve marriage, health-seeking, and childbearing. In the tribal community, the norm for marriage was elopement; dowries were never exchanged and the union was by mutual consent (**box 1**). In contrast, in the rural community, decisions about marriage were more formal; marriages were arranged by the elders and parents, and dowries were commonly demanded of the bride's family (**box 1**). Consent from the bride and groom was sought, if at all, only after the marriage had been finalized by a prior contractual agreement.

Tribal women were at liberty to take their children to a health-care center as needed, without receiving prior permission (**box 1**). For rural women, this process was more complex, with other family members often deciding when and whether to take a child to the health-care center (**box 1**). Most tribal women had the freedom to decide how many children to have and when and whether to have a tubectomy; however, the need for sons was still important to them, since sons carry the lineage forward (**box 1**). In contrast, rural women were not at liberty to decide how many children to have; this aspect of their life was decided for them by husbands and elders (**box 1**). Tribal women had greater freedom to travel alone, whereas rural women were admonished when they ventured anywhere alone (**box 1**). Responses to domestic violence also differed between tribal and rural communities. In the tribal community, women stated that family members became involved in cases of violence and communally condemned such behavior (**box 1**). In the rural communities, domestic violence was perceived as a normal daily occurrence that women felt they had to accept, and they felt that no one would become involved to stop the violence (**box 1**).

Quantitative findings

Moderate malnutrition in children, maternal malnutrition, and anemia were highly prevalent in the study sample (**table 1**). Malnutrition was significantly more prevalent in the tribal community (**table 1**). The mean values for anemia in children were not significantly different between the two groups (**table 1**). The characteristics of the tribal and rural women in the sample, such as maternal age and age at marriage, were not significantly different across the sample (**table 1**). Some degree of malnutrition was seen in 83.5% of the children and 72.4% of the mothers (**table 1**). In terms of demographic characteristics (**table 2**), the tribal subjects were more likely to come from nuclear families, whereas joint families were significantly more common among the rural subjects. Tribal families had more limited access to electricity, education, and health care than rural families. Tribal families were more food insecure, were more likely to purchase food on a weekly basis, and reported more days without food

TABLE 2. Socioeconomic, food security, and health characteristics of the sample (n = 820)

Characteristic	Tribal (%)	Rural (%)
Socioeconomic		
Family structure		
Nuclear	76.4	54.4
Joint	18.8	39.3
Other***	4.8	6.2
Type of house		
Pucca	75.4	83.9
Kuccha**[a]	24.3	16.1
Houses with electricity***	20.0	63.9
Household food security		
Frequency of food purchases		
Daily	53.5	78.0
Weekly	39.0	14.4
Monthly	7.5	7.7
Days without food in past month		
0	34.5	49.4
1–3	45.3	41.7
≥ 4–8***	20.3	8.9
Days without food in past week		
0	25.5	40.2
1	16.4	22.5
≥ 2***	58.1	37.2
Food production (farming)		
No production or no land	45.8	56.9
Woman and others	35.7	2.0
Husband and others***	18.6	41.1
Health-seeking behavior		
Time to health center		
< 1 h	68.8	92.7
≥ 2 h	28.3	5.7
Type of health center		
Government	56.6	26.4
Private***	42.9	72.1
Cost per health-center visit (rupees)		
0	23.5	12.1
< 100	64.9	73.5
> 100	11.3	13.1
Obtained credit for last health-center visit*	87.5	82.5
Obtained credit for health-center visit without husband's permission*	44.0	37.8

*$p < .05$; **$p < .01$; ***$p < .0005$

a. Pucca houses are houses with cement, asbestos, or tile roofing; kuccha houses are houses with thatched roofing.

(**table 2**). Tribal women, however, were significantly more likely to be involved in subsistence farming. Most subjects in both groups had to borrow money to pay for health care; rural subjects were more likely to use private health care (**table 2**). Child-feeding practices were similar across the sample, and more than 80% of the children were still being breastfed at the time of the study (**table 3**). Many mothers introduced complementary foods at an appropriate age (about 6 months), but diversity of the diet was poor (**table 3**). Tribal women had greater decision-making capabilities and freedom of movement than rural women (**table 4**). Tribal women were also more likely to be employed (**table 4**). However, the prevalence of domestic violence did not differ significantly between tribal and rural women (**fig. 2**).

Bivariate associations with children's weight-for-age were as expected (**table 5**). The biological variables maternal weight, children's dietary intake, and children's missed immunizations had the strongest association with children's weight-for-age. The next set of variables that were highly associated with children's weight-for-age consisted of the mother's mobility within the village (a function of her having the freedom to go to the local shops and her natal home if it

TABLE 3. Child-feeding practices[a]

Practice	Tribal (%)	Rural (%)
Breastfeeding		
Time from birth to initiation		
< 2 h	54.9	61.4
1 day	27.9	23.3
2–3 days	16.5	15.3
Colostrum given	51.2	51.5
Prelacteal feeds given	62.7	56.7
Currently breastfeeding	90.8	86.9
Complementary feeding		
Age when solids introduced (mo)		
< 4	7.4	6.1
4–6	53.3	54.0
7–11	21.5	24.0
≥ 12	8.2	8.3
Not yet started	9.6	7.4
Who feeds child		
Mother	78.1	85.7
Child	9.2	2.5
Others	3.6	4.4
Foods offered		
Energy-dense foods	62.9	65.4
No food	37.1	34.6
Nutrient-dense foods	17.1	13.3
No. of food groups offered		
1	53.0	42.2
2	33.0	44.9
≥3	4.3	5.2

a. All values are nonsignificant.

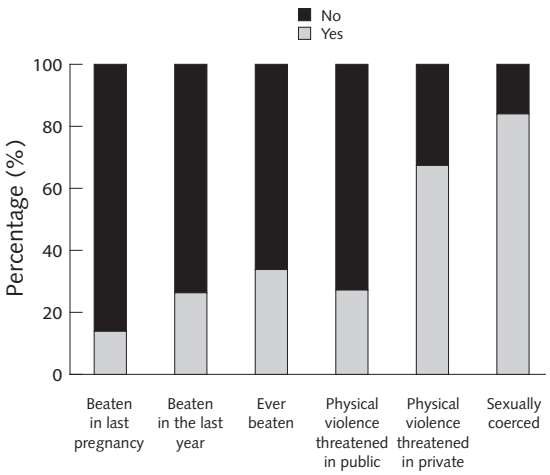

FIG. 2. Prevalence of domestic violence ($n = 820$)

TABLE 4. Women's capabilities: decision-making and physical mobility

Capability	Tribal (%)	Rural (%)
Decision-making		
Woman involved in major family decisions*	41.7	12.4
Marriage		
Couple decided upon marriage independently of others*	27.0	5.4
Family paid dowry*	1.9	40.8
Woman involved in family-planning decisions*	38.4	24.5
Woman involved in health-care-seeking decisions*	33.9	21.0
Employment		
Woman decided to work for wages*	23.1	7.4
Woman currently working for wages*	27.2	11.4
Control over food		
Woman obtains credit for food*	15.4	5.5
Woman buys household food*	50.1	16.5
Mobility: woman goes alone		
Shopping within the village*	55.3	21.3
To fields*	39.5	8.2
No land (families that do not own land)	45.8	57.2
To market*	11.4	3.0
To natal home*	50.5	23.8

*$p < .0005$

was nearby), the mother's being currently employed, the mother's having control over the household food supply, and the mother's having had antenatal care during her most recent pregnancy. Of the remaining variables, those that are related to family structure also had strong associations with child weight-for-age, in particular the mother's higher position within the household and her greater involvement in decision-making. Maternal education had only a weak association with children's weight-for-age in this sample. However, both maternal and paternal education had a strong association with maternal weight and BMI in bivariate regression analyses (**table 5**). Several of the women's empowerment variables also had a strong association with maternal weight and BMI. Among these, the mother's experience of psychological abuse and sexual coercion had the strongest association with both maternal weight and maternal BMI.

In the multivariate regression analysis (**table 6**), the biological variables explain the greatest variance

TABLE 5. Bivariate regression analysis of the independent variables on the dependent variable weight-for-age ($n = 820$) and maternal weight and maternal BMI for nonpregnant mothers ($n = 747$)

	Child weight-for-age z score		Maternal weight (kg)		Maternal BMI (kg/m^2)	
Independent variables	*F*	*p*	*F*	*p*	*F*	*p*
Biological variables						
Maternal weight (kg)	69.3	< .0005	—	—	—	—
Maternal BMI (kg/m^2)	43.1	< .0005	—	—	—	—
Child hemoglobin (g/l)	28.4	< .0005	—	—	—	—
Maternal hemoglobin (g/l)	14.1	<.0005	—	—	—	—
Nutrition and health variables						
Missed immunizations	25.7	< .0005	—	—	—	—
Antenatal care and cost	21.2	< .0005	17.9	< .0005	19.4	< .0005
Private health care	10.4	< .005	9.4	< .005	7.0	< .01
Age at first pregnancy and child mortality	—	—	6.3	< .05	—	—
Energy-dense foods	17.4	< .0005	—	—	—	—
Breastfeeding practices	5.9	< .05	—	—	—	—
Health decisions and woman's mobility	5.3	< .05	—	—	—	—
Food insecurity	4.9	< .05	—	—	—	—
Family type and food purchasing	14.8	< .0005	—	—	—	—
Time, cost, and health decisions	8.7	< .005	—	—	—	—
Women's empowerment variables						
Mobility within the village	24.7	< .0005	5.9	< .05	7.6	< .01
Mother's control over food supply	22.7	< .0005	5.7	< .05	5.8	< .05
Mother's current employment and income	22.7	< .0005	—	—	—	—
Mother's position in household and involvement in decision-making	17.0	< .0005	—	—	—	—
Mother's previous employment	12.1	< .005	9.1	< .005	12.1	< .005
Family type and mobility around village	9.4	< .005	—	—	—	—
Women's decisions	7.1	< .01	—	—	—	—
Psychological abuse and sexual coercion	5.2	< .05	11.3	< .005	10.8	< .005
Natal home and distance	4.3	< .05	6.6	< .05	12.0	< .005
Socioeconomic variables						
Family structure and income	18.0	< .0005	—	—	—	—
Family type and size	17.6	< .0005	—	—	—	—
Husband's education	8.3	< .005	39.8	< .0005	41.7	< .0005
Maternal education (years in school)	7.4	< .01	31.5	<.0005	36.4	< .0005
Mother currently illiterate	7.5	<.01	24.8	< .0005	35.5	< .0005
Family's employment security	—	—	16.5	< .0005	15.3	< .0005
Household water and sanitation	5.8	< .05	10.7	< .005	11.6	< .005
Household assets	—	—	4.4	< .05	—	—

BMI, body-mass index

TABLE 6. Multivariate regression analysis of cross-sectional weight-for-age data (n = 820)

	Weight-for-age (z score)											
	Model 1 Biological variables		Model 2 Nutrition and health variables		Model 3 Socioeconomic variables		Model 4 Women's empowerment variables		Model 5 Final model I		Model 6 Final model II	
Variable	b	t	b	t	b	t	b	t	b	t	b	t
Maternal weight	0.25	7.51****	—	—	—	—	—	—	0.23	7.14****	0.23	7.01****
Maternal hemoglobin	0.08	2.43*	—	—	—	—	—	—	0.08	2.50**	0.08	2.42*
Child hemoglobin	0.10	3.02***	—	—	—	—	—	—	0.09	2.72**	0.10	2.90***
Missed immunizations	–0.11	–3.43***	—	—	—	—	—	—	–0.10	–3.05***	–0.09	–2.84**
Energy-dense foods	–0.23	–5.66****	—	—	—	—	—	—	–0.20	–5.05****	–0.20	–5.00****
Nutrient-dense foods	–0.17	–4.21****							–0.12	–3.70****	–0.15	–3.71****
Breastfeeding practices	—	—	–0.08	–2.28***	—	—	—	—	—	—	—	—
Who feeds child	—	—	0.07	2.01*	—	—	—	—	—	—	—	—
Antenatal care and cost	—	—	–0.11	–3.21***	—	—	—	—	—	—	—	—
Family type and food purchasing	—	—	0.10	2.84*	—	—	—	—	—	—	—	—
Woman's control over food supply	—	—	0.10	2.76**	—	—	—	—	—	—	—	—
Private health care	—	—	0.07	2.12*	—	—	—	—	0.08	2.34**	0.07	2.06**
Time, cost, and health decisions	—	—	–0.10	–3.06***	—	—	—	—	–0.08	–2.58**	–0.09	–2.83**
Water and sanitation	—	—	—	—	–0.07	–2.15*	—	—	—	—	—	—
Family structure and income	—	—	—	—	0.14	4.10****	—	—	—	—	—	—
Maternal employment and income	—	—	—	—	—	—	–0.11	–2.86***	–0.12	–3.70****	—	—
Mother's position in household and involvement in decision-making	—	—	—	—	—	—	0.11	3.33***	0.09	2.65**	0.08	2.55*
Mobility within the village	—	—	—	—	—	—	0.10	2.53*	—	—	0.09	2.78**
Natal home and distance	—	—	—	—	—	—	0.07	2.02*	—	—	—	—
Psychological abuse and sexual coercion	—	—	—	—	—	—	–0.07	–2.10*	—	—	—	—
Interaction term Maternal employment and food insecurity											–0.07	–2.21*
Constant		–9.62****		–57.71****		–56.58****		–57.53****		–9.60****		–9.66****
No. of observations		820		820		820		820		820		820
Adjusted R^2	0.151		0.062		0.025		0.056		0.182		0.182	

BMI, body-mass index
*$p < .05$; **$p < .01$; ***$p < .005$; ****$p < .0005$

(15.1%) in the sample. The socioeconomic variables explain the least, and in fact are excluded in the final models (models 5 and 6). The nutrition and health variables and the women's empowerment variables explain a similar proportion of the variance in the sample.

Consistently, maternal weight and children's hemoglobin had a strong positive association with children's weight-for-age (**table 6**). Missed immunizations and lack of energy- and nutrient-dense foods showed a strong negative association with children's weight-for-age. Belonging to a joint family rather than a nuclear family had a positive association with children's weight-for-age. In the final models (models 5 and 6), the nutrition and health variables and the women's empowerment variables that remain in the models include the mother's position in the household, her involvement in decision-making, the family choosing private health care, her being currently employed, and the time, cost, and delay involved in seeking health care. Both maternal employment and the time, cost, and delay involved in seeking health care have an inverse relationship with children's weight-for-age. In model 6, because maternal employment interacts with the mother's mobility and household food insecurity, these two were introduced as interaction terms in the regression. In this final model, both the mother's physical mobility within the village and her position in the household and decision-making involvement have a positive association with children's weight-for-age. Both models 5 and 6 explain 18.2% of the variance in the sample.

Table 7 presents a multivariate logistic regression that compares the upper and lower quartiles of children's weight-for-age. The trends seen here are similar to those seen in **table 6** for the multivariate regressions. Higher maternal weight and children's hemoglobin level reduce the risk of low children's weight-for-age, whereas missing immunizations and not being offered energy- or nutrient-dense foods significantly increase the risk of low weight-for-age. In the final model (model 5), using private health care reduces the risk of children's low weight-for-age, but both maternal employment and the mother's experience of psychological abuse and sexual coercion significantly increase the risk of low weight-for-age.

Table 8 presents the findings of multivariate regression analyses of maternal weight and BMI. In **table 8A**,

TABLE 7. Multivariate logistic regression of cross-sectional weight-for-age data comparing upper and lower quartiles ($n = 522$)

	Weight-for-age z score				
Variable	Model 1 Biological variables Exp B	Model 2 Nutrition and health variables Exp B	Model 3 Socioeconomic variables Exp B	Model 4 Women's empowerment variables Exp B	Model 5 Final model Exp B
Maternal weight	0.894***	—	—	—	0.895***
Child hemoglobin	0.808*	—	—	—	0.807*
Missed immunizations	4.841**	—	—	—	5.836**
Energy-dense foods	5.013***	—	—	—	4.017***
Nutrient-dense foods	8.028***	—	—	—	8.898***
Who feeds child	—	0.713*	—	—	—
Antenatal care and cost	—	1.569**	—	—	—
Family type and food purchasing	—	0.755*	—	—	—
Private health care	—	0.637**	—	—	0.582**
Time, cost, and health decisions	—	1.265*	—	—	—
Family type and size	—	—	1.489***	—	—
Maternal employment and income	—	—	—	1.699*	2.168**
Mother's position in household and involvement in decision-making	—	—	—	0.695*	—
Mobility within the village	—	—	—	0.639*	—
Psychological abuse and sexual coercion	—	—	—	1.426*	1.429*
Constant	138.574***	7.419*	6.236***	7.807***	157.923***
No. of observations	522	522	522	522	522
–2 log likelihood	347.377	386.956	418.615	386.748	317.344

*$p < .05$; **$p < .005$; ***$p < .0005$

for both models 1 and 2, the variables associated with the dependent variables are similar. The husband's education, the mother's close proximity to the natal home, and use of private health care are positively associated with maternal weight and BMI. Lower parity is also positively associated with maternal BMI. Lack of antenatal care for the mother, less employment security for the family, and the mother's experience of psychological abuse and sexual coercion are negatively associated with maternal weight and BMI. The adjusted R^2 values for these models are low, as expected given the type of data; adult weight is more likely to be affected by external influences not captured by these data. Similarly, in **table 8B**, mothers have a 32% increased risk of having low BMI if they experience psychological abuse and sexual coercion. Lower parity for the mother, having control over the food supply, and being close to her natal home reduced the risk of low BMI. The husband's education also marginally decreased the risk of low maternal BMI.

Table 9 presents findings from additional analysis. The mother's position in the household and involvement in decision-making were positively associated with her having been previously employed and the husband's level of education. A shorter duration of marriage and maternal experience of psychological abuse and sexual coercion were both negatively associated with maternal involvement in decision-making. Similarly, the mother's mobility within the village was negatively associated with maternal employment; this is consistent with how the data were coded (high mobility was given a low score, and low mobility a high score). Working mothers were more mobile within and around the village. Previous maternal employment experience had a positive association with mobility within the village, whereas maternal experience of physical violence had an inverse relationship with mobility within the village.

Discussion

The qualitative data agree well with the quantitative findings, suggesting that the survey tool successfully measured women's empowerment. The qualitative

TABLE 8. Multivariate regression analysis with maternal weight and BMI as dependent variables and multivariate logistic regression analysis by BMI less than and greater than 18.5 kg/m^2

A. Multivariate regression analysis with maternal weight and maternal BMI as dependent variable (nonpregnant mothers) (n = 747)

	Model 1 Maternal weight		Model 2 Maternal BMI	
Variable	b	t	b	t
Husband's education	0.174	4.708**	0.183	4.849**
Mother currently illiterate	—	—	–0.103	–2.623****
Antenatal care and cost	–0.91	–2.515****	–0.073	–1.980****
Parity, birth order, and birth interval	—	—	0.107	3.033***
Private health care	0.088	2.459****	0.073	2.073****
Family's employment security	–0.090	–2.470****	—	—
Psychological abuse and sexual coercion	–0.089	–2.494*	–0.071	–1.980****
Natal home and distance	0.072	2.022****	0.101	2.854*
Constant		179.150**		57.403**
No. of observations		747		747
Adjusted R^2	0.086		0.104	

B. Multivariate logistic regression of nonpregnant mothers: BMI less than or greater than 18.5 kg/m^2 (n = 747)

Variable	Exp (B)	95% CI
Husband's education	0.947***	0.909–0.988
Parity, birth order, and birth interval	0.769*	0.649–0.911
Mother's control over food supply	0.722*	0.589–0.885
Psychological abuse and sexual coercion	1.321*	1.110–1.572
Natal home and distance	0.766*	0.643– 0.914
Constant	1.900	
No. of observations	747	
–2 log likelihood	810.186	

BMI, body-mass index; CI, confidence interval
*$p < .05$; **$p < .01$; ***$p < .005$; ****$p < .0005$

TABLE 9. Predictors of women's decision-making capabilities and freedom of movement ($n = 820$)

	Decision-making factors: mother's position in household and decision-making involvement		Freedom-of-movement factors: mobility within the village	
Predictor	b	t	b	t
Maternal employment and income			–0.498	–17.680*
Mother's previous employment	0.123	3.547*	0.321	11.390*
Physical violence			–0.059	–2.068*
Psychological abuse and sexual coercion	–0.072	–2.169*		
Husband's education	0.096	2.781*		
No. of years married	–0.245	–7.197*		
Constant		4.690**		0.000
No. of observations		820		820
Adjusted R^2	0.117		0.361	

*$p < .05$; **$p < .0005$

findings in this study revealed that women's empowerment varied according to community norms and the women's age. These data provided a strong base from which quantitative measures could be developed to measure women's empowerment. Few studies have applied this level of rigor to develop a context-specific survey tool that comprehensively captures the concepts represented within an empowerment framework.

After controlling for the known immediate and underlying causes of malnutrition, this study finds that women's empowerment variables are significantly associated with child weight-for-age and maternal nutritional status. Where young mothers are empowered to make decisions and have greater freedom of movement, their children's nutritional status tends to be better. Conversely, young mothers' experience of violence disempowers them and undermines their own and their children's nutritional status. The strong positive association between maternal nutritional status and children's weight-for-age shows that malnutrition is intergenerational in nature [7]. The socioeconomic variables have a weak association with child weight-for-age, suggesting that the sample is relatively homogeneous in these terms. Moreover, maternal education did not remain in the final models, suggesting that the variable and its effect are negligible in the sample. The health-seeking behavior variables reflect how much families can and do invest in their children's health and also how effective they are in obtaining resources, such as credit, to go to the health center. As in other studies, current maternal employment had a strong negative association with child weight-for-age, which most likely reflects poorer households that are more food insecure in which mothers must work for wages [24, 25]. This also explains the significance of the interaction term between current maternal employment and food insecurity, why more tribal women worked for wages, and the higher rates of malnutrition among the tribal children. This inverse relationship with children's weight-for-age also suggests that these families may not have had access to adequate child-care arrangements. Fewer rural women in our sample worked outside the home, and this most likely reflects the facts that they belong to joint families and have little choice in whether to work or not, and also that families decide to keep young mothers at home to look after their young children, as noted in Desai and Jain's study [35]. Interestingly, previous maternal employment (before marriage or the birth of their first child) predicts greater decision-making capabilities and freedom of movement in mothers, which suggests that it empowers women.

Mean maternal age at the time of the study was low, and early marriage and childbearing were the norm, as elsewhere in India. Nonetheless, the degree of variation in empowerment among mothers is important to note, because young mothers with young children are usually the focus of nutrition programs. It suggests that although younger women are probably still less empowered than older women, there is room to empower them even within the existing sociocultural context.

There are, however, two examples in the data where empowerment itself is not enough to prevent child malnutrition. Although tribal women are more empowered than rural women, child-feeding practices are the same in the two groups. This suggests that even though tribal women are more empowered, tribal and rural mothers alike do not have enough knowledge about appropriate feeding practices. Similarly, the higher rate of malnutrition in tribal children is most probably a consequence of the remote, resource-poor settings in which they live. It also suggests, however, that where access to information and resources is extremely limited, empowerment alone is insufficient to prevent malnutrition.

Although community responses to domestic violence were different in the tribal and rural communities, the quantitative data revealed that the prevalence of vio-

lence was not significantly different. Violence is most likely a consequence of poverty, which is common to both groups. But the difference in how the community responds does suggest that there is a fundamental difference in how women are valued in these communities. As in other studies, psychological abuse is more prevalent than physical violence, and the overall prevalence of violence is consistent [36, 37]. Among mothers who experience psychological abuse, 50% also admitted to having experienced physical violence. The independent associations seen between psychological violence and mothers' empowerment, maternal nutritional status, and children's nutritional status suggest that this form of violence operates through two pathways. Psychological violence directly exacerbates malnutrition and indirectly disempowers mothers, which also exacerbates malnutrition.

In general, tribal communities are more disadvantaged economically and tend to have higher rates of malnutrition, as seen here [44]. Tribal communities need much greater access to information, opportunities, and resources to improve women's and children's nutritional status. In contrast, rural communities have relatively greater access to resources, but women's lack of empowerment limits their ability to use these resources. Enabling gender equality is therefore important and can be achieved through women's self-help groups and transformation of health and nutrition programs to better address the needs of women and children in these settings.

Conclusions

The larger social context, and gender inequality in particular, play a role in the prevalence of malnutrition at the community level in this region of Karnataka, India. Moreover, these findings seem to suggest that the combination of empowerment with knowledge and resources can further reduce malnutrition significantly, more than any one of these inputs alone. Further research on the nexus between women's empowerment, domestic violence, and nutrition outcomes is clearly needed. In particular, given the high prevalence of domestic violence in developing countries, there is a need to understand the extent to which women's experience of violence undermines nutrition outcomes, women's caring capacity, and women's ability to become empowered. At a broader level, it is necessary to implement strategies to end violence against women.

These findings add to the body of evidence that concerted efforts are needed to improve women's nutritional status overall and that they should target women before, during, and after pregnancy. Strategies to raise the age of marriage and delay first pregnancy are also important in this context. In this study, the poorest families pay a high price when mothers have to work; at the household level, families lack alternatives in terms of income generation and child care. Women urgently need better child-care alternatives and a wider range of income-generation and employment opportunities from which they may obtain incomes equal to those of men.

Continued efforts on the part of existing programs that address malnutrition, seek to make families food secure, and enable access to health care are necessary. However, these study findings suggest that existing and new nutrition programs would benefit from parallel efforts to promote gender equality and empower women and girls. Further operations research is needed in community-based nutrition programs to determine whether empowering women can have a multiplier effect on improving nutrition outcomes, and how this can be achieved. At the community level, a next step for nutrition programs is understanding and overcoming the constraints women face because of their lack of decision-making authority, restricted freedom of movement, experience of domestic violence, and lack of access to and control over resources such as time and money. Addressing these gender constraints could lead to better-designed nutrition programs and improved program effectiveness for a greater and more sustainable impact on reducing malnutrition.

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Assessment of nutritional status of children under five years of age, pregnant women, and lactating women living in relief camps after the tsunami in Sri Lanka

Renuka Jayatissa, Aberra Bekele, C. L. Piyasena, and S. Mahamithawa

Abstract

Background. *A strong earthquake that hit Aceh on December 26, 2004, triggered a powerful tsunami, resulting in an unprecedented catastrophe in Sri Lanka. The initial phase of the disaster was marked by limited access to food coupled with an inadequate supply of safe water and poor environmental hygiene and sanitation, all of which placed children at increased risk for undernutrition.*

Objective. *To assess the nutritional status of children under five years of age, pregnant women, and lactating women residing in 40 relief camps after the tsunami.*

Methods. *A cross-sectional, 30-cluster study was performed. Thirty children under five from each cluster (camp) and all pregnant and lactating women in selected camps were studied. Data were collected by interviews with the primary caregivers of the children, interviews with key informants in the camps, direct observation, and focus group discussions with mothers. Weight, height, or length was measured on children and pregnant women. Mid-upper-arm circumference of lactating women was measured.*

Results. *A total of 878 children were assessed, of whom 16.1%, 20.2%, and 34.7% were wasted, stunted, and underweight, respectively. The prevalence of each indicator was higher in boys than in girls. During the 2 weeks before the survey, 69.5% of the children had acute respiratory tract infections and 17.9% had diarrhea. Although the general food distribution was well in place, the food supply lacked diversity, and 70.9% of the children did not get appropriate supplementary food. The prevalence of undernutrition among pregnant women* (n = *168) was 37%. Thirty-one percent of lactating women* (n = *97) were underweight, and 20% were overweight.*

Conclusions. *The prevalence of both acute and chronic undernutrition among children in the camps is significantly higher than the national Sri Lankan average. There is a need to establish nutritional surveillance systems to monitor the nutritional status of displaced and nondisplaced children and mothers.*

Key words: Children, lactating women, pregnant women, tsunami

Introduction

Sri Lanka is an island with a land area of approximately 65,654 km^2. It has a mountainous area in the south-central region ranging in elevation from about 300 to 2,524 m. The coastal plain occupies the rest of the island, being narrower in the west and south but broadening out in the east and north. The climate of Sri Lanka is tropical, with an annual average rainfall ranging from less than 1,000 mm across the northwest and southeast of the island to more than 5,000 mm on the southwestern slopes of the central hills [1]. Sri Lankans are not much used to facing natural disasters, since there have been very few in the history of the island.

The tsunami, which was one of the most destructive natural catastrophes in recent times, hit the coastal areas of Asia and some parts of Africa, taking more than 300,000 human lives. When the tidal waves hit Sri Lanka on December 26, 2004, 30,527 people died, 773,636 were displaced, and 15,686 were injured. Massive waves swept over the low-lying coast without any warning, flattening buildings and sweeping people away. The damage to the infrastructure was similarly extensive. More than 96,000 houses were destroyed and 26,528 were partially damaged. To accommodate the displaced population, 739 camps were established in temples, schools, and churches.

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The disaster caused massive displacement of entire communities. The survivors lost their assets and loved ones and became dependent on relief assistance. Some suffered from the devastating effects of exhaustion, bereavement, ill health, and injury. They were placed in a situation where food availability was limited and access to safe water and sanitation was poor.

Indicators related to nutritional status are considered to be the most vital indicators of the well-being of the population during emergencies. These indicators are useful to identify needs, prioritize the use of resources, track changes, and prevent the deterioration of the nutritional status of the population.

Even before the tsunami disaster, undernutrition (children < –2 SD of weight-for-age) was the primary developmental challenge for Sri Lankan children. A demographic and health survey in 2000 indicated that 14.0%, 13.5%, and 29.4% of children under five years of age were wasted, stunted, and underweight, respectively [1]. Among children under five years, the prevalence of anemia was 30%, and prevalence of serum retinol levels below 20 μg/L was 33.3% [2, 3]. The literacy level among adults in 2001 was 92.5%, with a female literacy rate of more than 90%. Female life expectancy at birth exceeded 75 years in 2001 [4]. Although Sri Lanka has made impressive achievements in child survival, undernutrition among children remains a significant public health problem. With the onset of the tsunami and the subsequent population displacement, people lost their customary sources of food and were exposed to additional environmental risks, such as an inadequate supply of safe water and lack of sanitation and hygiene. These conditions were expected to increase the risk of undernutrition among vulnerable groups, in particular children and women.

A nutrition survey was needed to measure the extent and severity of malnutrition among the tsunami-affected population living in relief camps and to plan appropriate interventions. It was expected that the results of the nutrition survey would provide an update on the nutritional status of the affected population and could be used as baseline data for monitoring the impact of interventions, such as emergency food supplies and other relief efforts.

In order to collect baseline information from people living in the relief camps, facilitate relevant actions, and monitor the situation, UNICEF, together with the World Food Program (WFP), supported a nutrition survey in camps housing displaced people conducted by the Medical Research Institute of the Ministry of Healthcare and Nutrition. The objectives of the study were to assess the nutritional status of children under five, lactating women, and pregnant women living in relief camps and to document the determinants of undernutrition in the relief camps.

Methods

A cross-sectional, two-stage, 30-cluster, rapid assessment nutrition survey was carried out. Each relief camp was considered a cluster. Sample size was calculated on the basis of an expected estimated prevalence of wasting among the displaced population of 20%, with a 95% confidence interval and 5% error. The design effect was determined to be 3.5 due to the clustering effect of camps. The calculated sample size for statistical significance was 900 children under five.

Only 12 of 25 coastal districts in Sri Lanka were directly affected by the tsunami. During the first stage of sampling, the number of camps included from each affected district was selected randomly with the probability proportional to the affected population size in the district. At the second sampling stage, the required number of camps from each district was randomly selected.

In each selected camp, 30 children were randomly selected from a list maintained by the camp managers using computer-generated random numbers. If 30 children were not available from a selected camp, children were recruited from the nearest relief camp from the same locality to fulfill the sample size. A total of 40 camps were studied. Pregnant women and lactating mothers in the selected relief camps were measured after obtaining consent.

Data collection

Data were collected by trained and experienced staff. The survey team consisted of two or three members of the staff of the Department of Nutrition and the Nutrition Coordinating Division. Six teams were deployed, each covering five camps (one camp per day) during the survey. The data collection period was January 17 to 28, 2005. The investigators interviewed the primary caregivers of children under five years (mothers, fathers, or other caregivers), took anthropometric measurements, conducted focus group discussions with caregivers, interviewed key informants (camp managers), and made direct observations of the conditions in the camps.

An interviewer-administered questionnaire was used to collect information from the primary caregivers of under-five children on basic demographic characteristics (age or date of birth and sex), illnesses, feeding patterns, access to water and sanitary facilities, and dietary diversity.

The weight, height, or length of children under five years, mid-upper-arm circumference of pregnant women, and weight and height of lactating women were measured using standard techniques described by the World Health Organization (WHO) [5]. Weight was measured to the nearest 100 g with a Seca electronic scale while the subject was wearing minimal clothing and no shoes. The accuracy of the scale was checked

each morning with standard weights. No corrections were made for the weight of clothing, which averaged 25 g for children. The height or (in children under 2 years of age) length of children was measured to the nearest 0.1 cm with a measuring board. The weight of lactating women was measured with a stadiometer, with the woman not wearing shoes and her head held in the Frankfort horizontal plane.

Focus group discussions were conducted by three experienced supervisors using an interviewer guide. A total of 15 focus group discussions were conducted (one group per camp), each of which included 6 to 10 caregivers from each selected camp. The participants were asked what foods were commonly given to the children, the frequency of consumption of different foods, whether the children's food consumption changed after they came to the camp, and what constraints there were on adequate care for the children.

The camp managers, serving as key informants, were interviewed to collect information on food availability and accessibility in the camp and access to health services, water, and sanitation.

During the survey the interviewers were asked to directly observe food availability and access to food, health, and sanitation. The survey team members were provided with checklists to facilitate the process.

Written ethical approval for this study was obtained from the Director General of Health Services, Ministry of Healthcare and Nutrition in Sri Lanka. Informed oral consent was obtained from camp managers and mothers or other caregivers before the interviews. All of the interviewers and measurement takers were healthcare personnel who had previous experience with nutritional surveys and who were trained in assessment methods and administration of the questionnaire. Pretesting of different data-collection techniques was carried out at the relief camp closest to the Medical Research Institute, and some corrections and rewording of the questionnaire were made. The medical specialists and medical officers of the Department of Nutrition, Medical Research Institute, closely monitored the fieldwork. All of the selected camps were accessible by driving. Orphaned children were also included in the study, since relatives or neighbors in the camps looked after them. The survey was conducted as a rapid assessment in a disaster, and therefore we focused on children living in relief camps.

Data analysis

Data were analyzed with the Statistical Package for the Social Sciences statistical software (version 10.0 for Windows; SPSS, Cary, NC, USA). Age was calculated in months from the child's date of birth. Although some birth certificates were lost in the tsunami, the majority of caregivers knew their children's birthdates. Weight-for-age, weight-for-height, and height-for-age were calculated for children by using ANTHRO/CDC (version 1.02; US Centers for Disease Control and Prevention, Atlanta, Ga, USA) software. National Center for Health Statistics (NCHS) reference data were used. The cutoff point for stunting, wasting, and underweight was a z score below –2SD of the reference value, according to WHO guidelines [6]. The body-mass index (BMI) of lactating women was calculated as the weight in kilograms divided by the square of the height in meters. Women with BMI < 18.5 were considered underweight and those with BMI > 24.9 were considered overweight [6]. The cutoff points for mid-upper-arm circumference (MUAC) of pregnant women were ≤ 230 mm for acute undernutrition and ≤ 207 mm for severe acute undernutrition [7]. Chi-square values and odds ratios were calculated, and $p < .05$ was considered to indicate statistical significance.

Results

A total of 30 camps were included in the study. Basic demographic information from populations in the selected camps is given in **table 1**. The population of the camps ranged from 253 to 2,594 (median, 446). The median number of children under five in these camps was 32 (range, 20 to 189). A total of 905 children under five years of age, 97 lactating women, and 168 pregnant women in the camp population were included in the study.

In the study sample, 3% of the records were not usable and excluded from analysis, so that 878 children were included in the analysis. The majority of respondents (89.6%) were mothers, 5.8% were fathers, and 4.6% were other caregivers. The mean number of days spent in the camp was 23, ranging from 1 to 32. Children 1 to 5 years of age were evenly distributed according to sex, with 49.1% boys and 50.9% girls.

Prevalence of wasting, stunting, and underweight

The overall prevalence of wasting (percentage of subjects –2 SD below the NCHS/WHO weight-for-height reference) was 16.1% (**table 2**). The prevalence of wasting increased and then decreased with age and was lowest at 24 to 35.9 months of age. The highest prevalence of wasting (31.2%) occurred at 12 to 23.9 months.

TABLE 1. Selected characteristics of the population of 30 camps

	Median	Range
Total population	446	253–2,594
Children < 5 yr	32	20–189
Women > 18 yr	96	43–578
Elders > 60 yr	12	5–99
Men > 18 yr	90	45–552

TABLE 2. Prevalence, confidence intervals, mean z scores, and SDs of the study sample according to age and sex in comparison with national values

	Weight-for-height		Height-for-age		Weight-for-age	
Variable	% wasting [95% CI]	Mean WHZ (±SD)	% stunting [95% CI]	Mean HAZ (±SD)	% underweight [95% CI]	Mean WAZ (±SD)
Age (mo)						
< 12 (n = 163)	9.9 [3.2–14.0]	–.59 (2.0)	9.6 [6.7–14.1]	0.4 (2.9)	8.2 [9.6–21.1]	–0.47 (2.1)
12–23.9 (n = 199)	31.2 [14.9–29.2]	–1.32 (1.2)	24.3 [14.7–28.5]	–0.85 (1.8)	24.9 [30.8–45.6]	–1.58 (1.1)
24–35.9 (n = 193)	17.0 [9.0–15.8]	–1.19 (1.1)	20.9 [11.9–26.4]	–0.84 (1.7)	22.9 [29.4–43.6]	–1.66 (1.0)
36–47.9 (n = 185)	20.6 [10.5–20.9]	–1.22 (1.2)	26.6 [19.7–31.1]	–1.33 (1.5)	25.9 [35.2–50.3]	–1.79 (1.3)
≥ 48 (n = 138)	21.3 [14.8–28.7]	–1.22 (1.3)	23.9 [17.3–30.5]	–1.35 (1.5)	18.0 [34.1–45.6]	–1.83 (0.9)
Sex						
Male (n = 444)	17.3 [13.4–21.1]	–1.2 (1.2)	22.4 [18.7–26.0]	–0.9 (2.0)	36.4 [32.2–40.6]	–1.5 (1.4)
Female(n = 461)	14.9 [11.5–18.3]	–1.1 (1.6)	18.0 [14.2–21.9]	–0.7 (2.1)	33.3 [28.9–37.8]	–1.4 (1.5)
Total (n = 878)	16.1 [13.1–18.9]	–1.11 (1.4)	20.2 [16.9–23.4]	–0.79 (2.04)	34.7 [31.6–37.9]	–1.47 (1.4)
National values[a]	14.0	—	13.5	—	29.4	—

CI, confidence interval; WHZ, weight-for-height z score; HAZ, height-for-age z score; WAZ, weight-for-age z score
a. Demographic and Health Survey 2000 [1].

The prevalence of wasting was higher in boys than in girls, but the difference was not significant (17.3% vs. 14.9%; p = .37). The overall prevalence of stunting (the percentage below –2 SD of the NCHS/WHO height-for-age reference) was 20.2%. The prevalence of stunting among boys (22.4%) was higher than that among girls (18.0%). The overall prevalence of underweight (percentage below –2 SD of the NCHS/WHO weight-for-age reference) was 34.7%. The prevalence of underweight increased and then decreased as age increased for both sexes. In this population, the highest prevalence of underweight (25.9%) occurred between 36 and 47.9 months.

Only seven (0.8%) children were severely wasted (below –3 SD of the NCHS/WHO weight-for-height reference). Most of the wasted children were moderately wasted (between –2 SD and –3 SD of the NCHS/WHO reference) (**fig. 1**). The prevalence of severe wasting was highest among children under 1 year of age (1.8%).

Determinants of undernutrition

Data were also collected on factors possibly related to undernutrition, including disease prevalence, feeding frequency, dietary diversity, mans of livelihood prior to the tsunami, access to water and sanitation, coping strategies, and deaths.

The incidence of serious illnesses among the children during the 2 weeks prior to the study was determined. Acute respiratory tract infection, as determined by public health inspectors, was defined as cough or cold with or without fever. **Table 3** shows that 69.5% of children under five had suffered from acute respiratory tract infections and 17.9% had had diarrheal disease (three or more loose stools) in the previous 2-week period. The highest prevalence of acute respiratory

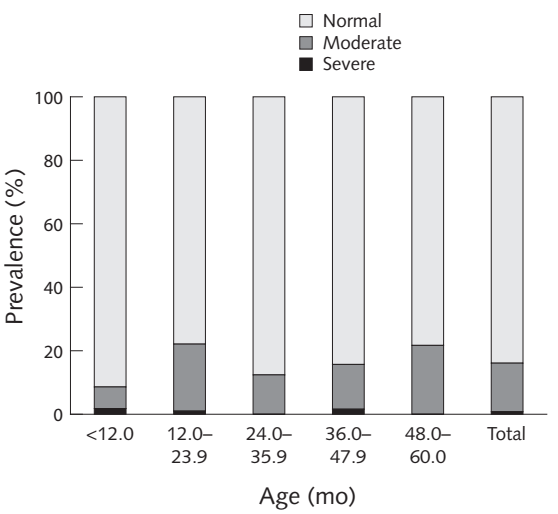

FIG. 1. Prevalence of moderate and severe wasting among children according to age group (n = 878)

TABLE 3. Disease prevalence and vitamin A megadose supplementation in the study population according to age group (n = 878)

Condition	Age (mo)						Total
	< 6	6–11.9	12–23.9	24–35.9	36–47.9	≤ 48	
Diarrhea (%)[a]	6.4	11.5	35.7	19.1	17.8	9.6	17.9
ARI (%)[b]	4.8	13.0	24.9	21.8	20.7	14.9	69.5
Vitamin A supplemented (%)[c]	2.1	18.2	33.2	19.8	18.7	8.0	22.9

ARI, acute respiratory tract infection

a. Diarrhea is defined as the passage of three or more loose stools in the preceding 2 weeks. $\chi^2 = 20.8$, $p < .05$.

b. Acute respiratory infection is defined as cough or cold with or without fever in the preceding 2 weeks. $\chi^2 = 10.2$, $p > .05$.

c. Received vitamin A megadose within the previous 6 months. $\chi^2 = 30.1$, $p < .05$

tract infections (24.9%) and diarrhea (35.7%) was observed among children 12 to 23.9 months of age.

Routine supplementation with megadoses of vitamin A is provided for children 9 to 18 months of age in Sri Lanka through the maternal and child health clinics. Among the children in our study, only 20.8% of those over 6 months of age had received their vitamin A megadose during the previous 6 months. Among children 12 to 23 months of age, 33.2% had received their megadoses.

Table 4 shows the breastfeeding pattern among children in relation to age. During the study period, 94.1% of children under 6 months of age, 85.2% of children between 6 and 11.9 months of age, and more than two-thirds (69.8%) of children 1 to 2 years of age were being breastfed. A few children (7.6%) older than 48 months were also being breastfed. Of the children who were no longer being breastfed, more than half (51.4%) had stopped breastfeeding after the age of 18 months. A few children (3.3%) had never been breastfed.

The study also determined the frequency of feeding among children in relation to age. The majority of children under 6 months of age (78.8%), 6 to 11.9 months of age (64.0%), and 12 to 23.9 months of age (50.2%) were fed four or more times per day. More than half of the children older than 24 months of age were fed three times daily, and nearly one-third of them were fed four or more times per day.

Table 5 shows the food-consumption patterns of the children during the 24 hours prior to the interview. Children aged 6 to 11 months were fed mainly rice, milk, and sugar. Around three-fourths of the children (70.9%) had not received any supplementary foods, such as *triposha* (a fortified supplementary food produced in Sri Lanka and supplied by the government), corn-soya blend, or any other commercial products available in the markets. In our study population, 76.7% of infants 6 to 11 months of age had been given tea and beverages containing sugar; 79.1% had not received any kind of animal products such as fresh fish, meat, dried fish, or eggs; 76.4% had not received pulses or soya; and 90.9% had not received fats, coconut, or margarine. The main food source of the infants was breastmilk.

Children aged 12 to 23 months were fed mainly with rice, milk, pulses, and sugar. The majority of children had not received fruits, vegetables, or green leafy vegetables.

TABLE 4. Breastfeeding and child feeding practices according to age

Practice	Age (mo)						Total
	< 6	6–11.9	12–23.9	24–35.9	36–47.9	≥ 48	
Currently breastfed—no. (%) (n = 857)[a]	48 (94.1)	92 (85.2)	139 (69.8)	80 (43.0)	30 (16.6)	10 (7.6)	399 (46.9)
No. of feedings/day—%							
1	3.8	3.6	4.5	2.1	3.2	4.3	3.4
2	3.8	8.1	8.0	7.3	9.7	12.3	8.8
3	13.5	24.3	37.2	52.3	58.4	60.1	45.2
≥4	78.8	64.0	50.2	38.3	28.6	28.6	42.7

	Age (mo)					
	< 6	6–11.9	12–17.9	≥ 18	Never breastfed	No response
Stopped breastfeeding—no. (%) (n = 479)	39 (8.1)	60 (12.5)	106 (22.1)	246 (51.4)	16 (3.3)	12 (2.5)

a. Twenty-one children either had no mother or were orphans.

Respondents who were parents or caregivers of a child (95.4% of the sample) were asked what their means of livelihood was before the tsunami. About 40% of the respondents had been involved in the fishing industry, and 35.9% were day workers in jobs related to the fishing industry. Only 1.6% were dependent on agriculture as a means of livelihood. None were employed at the time of the interview.

At the camps, 70.2% of primary caregivers obtained their drinking water from bowsers (tanker trucks) and 57.7% also obtained their water for cooking and personal hygiene from bowsers. The majority (77.1%) felt that they had access to adequate quantities of safe drinking water in the camps. For personal sanitation, 70.4% of respondents used water-sealed toilets and 24.8% used temporary toilets such as trenches. Only 68.0% always washed their hands after defecation and 59.3% before preparation of foods.

Four-fifths (80.8%) of the caregivers stated that their children had enough food to eat during the 7 days prior to the interview. Some respondents reported that they did not have enough food for their children at three to six meals per week. They coped with the shortage of food by limiting children's portion sizes, restricting the quantities consumed by adults in order to feed the children, reducing the number of meals in a day, and going outside the camp to purchase food or obtain it from friends or relatives.

Table 6 shows that children with diarrhea (OR = 1.8) or acute respiratory tract infection (OR = 1.2) were at

TABLE 5. Dietary diversity of the children during a 24-hour period prior to interview according to age group*

Food group	No. of feedings/ 24 hr	Age (mo) 6–11 (n = 110)	12–23 (n = 202)	≥ 24 (n = 527)
		% of children consuming		
Rice, cereals, grains, wheat flour preparations	0	47.3	13.4	6.6
	1	21.8	22.8	14.6
	2	20.9	29.7	29.4
	3	10.0	33.2	48.0
	≥4	0.0	0.0	0.0
Yams, potatoes, other starchy foods	0	76.4	79.2	66.8
	1	16.4	17.3	28.5
	2	6.4	3.0	4.6
	3	0.9	0.5	0.2
	≥4	0.0	0.0	0.0
Pulses, soya products	0	76.4	54.0	47.4
	1	20.0	36.6	39.7
	2	2.7	8.9	11.8
	3	0.9	0.5	1.1
	≥4	0.0	0.0	0.0
Milk and milk products (excluding breastmilk)	0	23.6	10.9	10.8
	1	8.2	10.9	14.2
	2	20.0	38.1	48.4
	3	15.5	21.3	18.0
	≥4	32.7	18.8	8.6
Fresh fish, eggs, dried fish, meat, meat products	0	79.1	53.0	38.0
	1	16.4	32.2	39.5
	2	3.6	13.4	20.3
	3	0.9	1.5	2.3
	≥4	0.0	0.0	0.0
Sugar added to tea or beverages	0	43.6	23.3	22.6
	1	23.6	16.3	18.0
	2	26.4	40.1	41.7
	3	6.4	16.3	13.3
	≥4	0.0	4.0	4.3
Fats, coconut, margarine	0	90.9	71.8	60.3
	1	8.2	17.8	20.1
	2	0.9	8.9	18.2
	3	0.0	1.5	1.3
	≥4	0.0	0.0	0.0
Fruits	0	88.2	84.2	85.6
	1	8.2	14.4	12.3
	2	2.7	1.5	1.7
	3	0.9	0.0	0.2
	≥4	0.0	0.0	0.2
Vegetables (other than green leafy vegetables)	0	83.6	69.3	49.1
	1	10.0	21.3	34.5
	2	5.5	8.9	15.0
	3	0.9	0.0	1.3
	≥4	0.0	0.5	0.0
Green leafy vegetables	0	97.3	98.0	93.0
	1	0.9	2.0	6.1
	2	0.9	0.0	0.8
	3	0.9	0.0	0.2
	≥4	0.0	0.0	0.0
Beverages and water	0	99.1	96.5	96.8
	1	0.0	3.0	3.0
	2	0.9	0.0	0.2
	3	0.0	0.5	0.0
	≥4	0.0	0.0	0.0
Supplementary food (*triposha*, a corn-soya blend, commercial products)	0	70.9	81.7	92.8
	1	18.2	12.9	5.9
	2	9.1	5.0	0.8
	3	1.8	0.5	0.6
	≥4	0.0	0.0	0.0

a. Triposha is a fortified supplementary food produced in Sri Lanka and supplied by the government.

higher risk of wasting and underweight than children who did not have these conditions. Boys under five years were at higher risk for wasting, underweight, and stunting than girls of the same age.

Nutritional status of pregnant women and lactating women

The nutritional status of 168 pregnant women was determined by measurements of MUAC. Of pregnant women, 12% were suffering from severe acute undernutrition and 25% from moderate undernutrition. Only 97 lactating women (within 6 months of delivery) were found in the study camps. About one-third (31.1%) were underweight (BMI < 18.5) and 19.8% were overweight (BMI >24.9).

Focus group discussions

All camps provided cooked meals, and the residents participated in the cooking on a rotating basis. However, only adult food was served, and no separate food was provided for the children. Many caregivers felt that the meal patterns of children from 6 months to 5 years of age changed after they came to the camps and their appetites were reduced. The common foods given to children were rice, dhal, biscuits, and tea with milk. Some caregivers stated that they fed their children mainly biscuits and milk or tea with milk. There were no facilities for cooking family meals, and meals were served three times per day. The caregivers were concerned that the children did not get any vegetables and fruits. Children were given eggs and canned fish occasionally. Some children refused to eat the same kinds of food every day.

Most of the mothers continued breastfeeding without problems related to reduction of breastmilk volume. Some children were being fed with formula before the tsunami, and obtaining milk powder and ensuring its hygienic preparation in the camp was a problem.

The caregivers reported that the children had frequent coughs, colds, and fevers, but they felt that this was not unusual because the children had these symptoms frequently before the tsunami.

Interviews with key informants

The camp managers stated that the daily general food ration provided to all displaced people by the government included 200 g of rice, 60 g of dhal, 20 g of sugar, 200 g of wheat flour, 20 g of oil, and 5 g of salt. In addition, each person was provided with Rs. 200 (US$2) per week to purchase food items from the cooperative stores in the camps. The government also provided biscuits, milk powder, and canned fish occasionally. The food supply was not always stable, and the camp managers coped by reducing the quantity of rations. About three-quarters of the managers felt that the amount of food available in the camps was satisfactory. Only 6.5% of the managers received funds to purchase food from private donors. The managers reported that the children had to eat from a common pot of food. Most of the time children had to be fed only breastmilk and biscuits because the cooked food was too spicy for them.

The managers reported that each camp was visited by health-care workers on average 5 days per week. The mean (± SD) distance from a camp to a hospital or clinic facility was 2.8 ± 2.2 km. The managers stated that illnesses prevailing in the camps were fever with cough or colds and diarrhea; the managers used a number of approaches to organize medical services in the camps to attend to children's illnesses. These included establishment of medical services within the camp, mobile clinics, visits by a medical officer every two days, and medical services provided by the nearest hospital, or clinic.

The managers felt that the quality and quantity of drinking water in the camps were satisfactory. Nearly 68% of the managers reported that more than 20 people used one toilet. It was also found that different methods were used by mothers to dispose children's stools, which included disposing in toilets (77.4%), in the bushes (19.4%), and by other methods (3.2%).

TABLE 6. Risk of child malnutrition according to disease and sex (*n = 878*)

Factor	Wasting subjects (%)	Stunting subjects (%)	Underweight subjects (%)
Diarrhea	OR, 1.8; 95% CI, 1.17–2.69	OR, 1.2; 95% CI, 0.82–1.86	OR. 1.4; 95% CI, 0.98–1.97
Yes	38 (23.9%)	37 (23.3%)	66 (58.5%)
No	111 (15.0%)	145 (19.7%)	251 (33.8%)
ARI	OR, 1.4; 95% CI, 0.94–2.11	OR, 0.79; 95% CI, 0.56–1.16	OR, 1.0; 95% CI, 0.76–1.37
Yes	112 (18.0%)	119 (19.2%)	220 (35.3%)
No	37 (13.5%)	63 (23.1%)	97 (34.9%)
Sex	OR, 1.1; 95% CI, 0.79–1.59	OR, 1.1; 95% CI, 0.78–1.59	OR, 1.1; 95% CI, 0.84–1.45
Male	77 (17.4%)	77 (17.4%)	161 (36.3%)
Female	72 (15.8%)	72 (15.8%)	156 (34.1%)

ARI, acute respiratory tract infection; CI, confidence interval; OR, odds ratio

Direct observation of camps by interviewers

The camps were examined by the interviewers, most of whom were public health inspectors, with respect to sanitation and overcrowding. These inspectors had the knowledge, experience, and ability to assess sanitation and overcrowding levels. They reported that 83.2% of the camps visited were suitable as human shelters. About 3.3% of the study population were living under trees and 23.8% were in overcrowded conditions in the relief camps.

Discussion

This study describes the findings of the rapid assessment of nutritional status and related factors carried out by the Ministry of Health in Sri Lanka one month after the tsunami disaster. It is a representative survey among children under five years of age and pregnant and lactating women who were living in displaced-persons' camps as a result of the tsunami disaster. At the time of the study, most of the people in Sri Lanka who had been displaced by the tsunami were living in these camps.

This nutrition survey yielded a number of important findings. The prevalence of wasting among children under five was 16.1%, 2.1 percentage points higher than the national prevalence [1]. We believe this higher prevalence indicates the effect of short-term nutritional deprivation on children under five. A similar survey in Banda Aceh found that the prevalence of wasting was 12.7% [8]. However, in the Banda Aceh study, boys were more severely affected than girls, contrary to our findings. Our study found the highest prevalence of wasting (31.2%) among children between 12 and 23 months of age, a level much higher than the reported prevalence of 23% found among children between 12 and 24 months of age on the islands of Nias and Simeulue [8].

On the basis of the epidemiologic criteria established by WHO for assessing the severity of undernutrition in populations, this study demonstrated a high prevalence of wasting and underweight and a moderate prevalence of stunting among the children under five living in camps [6]. Although the national prevalence of wasting was high, it was not generally above the trigger point of 15% indicated by WHO as of high public health concern [6]. Although this study found a level of wasting higher than the trigger point in the camps, a very low level (0.8%) of severely wasted children was observed. One potential limitation of using DHS reference data is that the DHS survey was carried out in 2001 and it indicates overall prevalence without indicating regional variations.

This study also documented a high prevalence of stunting among the children in comparison with that seen at the national level. This observation documents that the nutritional status of this population may be a longstanding problem.

At the time of our study, about one-sixth of the children had recently had diarrhea and two-thirds had acute respiratory tract infections. The highest prevalence of acute respiratory tract infection and diarrhea was observed among children between the ages of 12 and 23 months, the same age group with the highest level of wasting. The prevalence of wasting was higher among children with diarrhea and acute respiratory tract infection.

Routine vitamin A megadose supplementation is provided for children 9 to 18 months of age in Sri Lanka through the maternal and child health clinics. We found, however, that only 33.2% of children 12–23 months had received their vitamin A megadose during the previous 6 months. This observation is compatible with the high incidence of acute respiratory tract infections, since vitamin A has been associated with resistance to infection [9].

Overall, breastfeeding practices were satisfactory, with about 94% of children under 6 months of age being breastfed at the time of the study. About 43% of the children were fed four or more times daily. On the basis of 24-hour recall, most of the children had an unbalanced and monotonous diet, consisting of rice, milk, and biscuits, with few vegetables, fruits, animal products, and pulses. More than two-thirds of the children did not receive micronutrient-fortified supplementary foods. Although an adequate quantity (as determined by caregivers) of food was given daily and consistently, the supply of optimum micronutrients from this diet is questionable.

Sugar added to tea or other beverages was one of the main sources of energy among all age groups. Although the Ministry of Health has recommended not adding sugar and salt to food for children under 1 year of age, 66.4% of infants (6 to 12 months) in this population were given added sugar in tea and other beverages. It is important to note that this could not be prevented under the circumstances of the disaster.

More than one-third of the men in the camps had been employed in the fishing industry, and another one-third were employed in day jobs related to the fishing industry. Even one month after the tsunami, when this study was conducted, most people were out of work and were receiving government assistance for shelter and food until they were able to establish a normal livelihood. The availability of clean water and sanitary facilities was adequate, and health-care personnel visited camps frequently to assess the situation.

About one-third of lactating women and more than one-third of pregnant women were underweight. Although the sample size was small, this observation suggests the need for specific nutritional interventions for these groups of women.

Food supply, sanitation, and access to water seemed to be satisfactory in the camps, according to the camp managers. Practices related to personal hygiene were not satisfactory overall, an observation suggesting the need for education in hygiene.

Even before the tsunami, undernutrition was the single greatest developmental challenge for Sri Lankan children [1]. It was expected that this situation would increase the risk of undernutrition among the usual vulnerable groups, in particular children and women.

Conclusions and recommendations

Malnutrition is a public health problem among children under five and pregnant and lactating women living in relief camps. It is important to translate these findings into targeted interventions through all sectors with effective coordination among all agencies to prevent the further deterioration of nutritional status. We recommend that a one-day vitamin A megadose supplementation campaign for children aged 6 months to 5 years be launched in tsunami-affected areas; that supplementary food (*triposha* or corn-soya blend) be supplied for all children under five and to pregnant and lactating women in the tsunami-affected areas for a minimum of 1 year; that nutrition surveillance systems be established in tsunami-affected areas; that social services departments and camp managers be advised to provide nutritionally complete food rations for children; and that capacity building of health workers on key nutrition interventions in health and nutrition in emergencies be initiated.

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Prevalence of challenging nutritional problems among adolescents in Sri Lanka

Renuka Jayatissa and R. M. Ranbanda

Abstract

Background*. Although 21% of the population of Sri Lanka consists of adolescents, studies of nutritional status among this group are limited.*

Objective. *To assess nutritional problems and dietary and activity patterns among adolescents in Sri Lanka.*

Methods*. A nationally representative cross-sectional study was conducted on 6,264 adolescents 10 to 15 years of age. All subjects were clinically examined for Bitot's spots, and their weights and heights were measured. The subjects were interviewed during regular class time. Hemoglobin concentration and dietary and activity patterns were assessed among a subsample (*n = *787) of 1,521 adolescents. The World Health Organization age- and sex-specific references for body-mass index and height-for-age were used to estimate the prevalence of underweight and stunting, respectively. The International Obesity Task Force age- and sex-specific reference for body-mass index was used to estimate the prevalence of overweight. Age-specific WHO-defined cutoff points were used to estimate the prevalence of anemia.*

Results. *The prevalence rates of underweight, stunting, and overweight were 47.2%, 28.5%, and 2.2%, respectively. The prevalence rates of anemia and vitamin A deficiency were 11.1% and 0.4%, respectively. During the previous 6 months, 10.4% of the subjects had usually not eaten breakfast before going to school. During the week before the interview, 24.4% of the children had not consumed green leafy vegetables, 26.6% had not consumed fruit, 19.0% had not participated in physical activities, and 27.5% had watched television for more than 2 hours per day.*

Conclusions*. The nutritional problems of adolescents aged 10 to 15 years should be addressed through the schools. Specific policies should be developed in collaboration with the Ministry of Health and Education to control nutritional problems among adolescents.*

Key words: Adolescents, overweight, stunting, underweight

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Introduction

Sri Lanka is confronting both extremes of malnutrition, since undernutrition (wasting and stunting) coexists with overnutrition (overweight and obesity). Some nutritional deficiencies, such as in the B vitamins and vitamin C, are slowly being reduced or eradicated in many parts of the Sri Lanka, but others, such as deficiencies in iron and vitamin A, are still prevalent to varying degrees in different parts of the country. On the other hand, coronary heart disease, cancer, and diabetes have become the leading causes of hospitalization [1].

Around 21% of the Sri Lankan population consists of adolescents, according to the World Health Organization (WHO) definition of adolescents as people from 10 through 19 years of age [2]. Traditionally, preschool-age children, pregnant women, and primary-school children have been targeted as nutritionally vulnerable populations in Sri Lanka; at present, however, the focus tends to be on nutrition-related chronic diseases among adult populations. Adolescents are an in-between group with some nutritional problems in common with both children and adults. Because adolescents have a low prevalence of infection in comparison with children under five years old and a low prevalence of chronic disease in comparison with the aged population, their health and nutrition has received little attention [2]. A multicountry study revealed that the prevalence of stunting among adolescents was between 27% to 65% in nine of 11 studies, and the prevalence of underweight between 23–53% in three of eight studies [3].

Children in Sri Lanka are legally required to remain

in school until the age of 14 years. Approximately 95% of children are enrolled in school at the age of 5 years, and there is no sex difference in enrollment (male: female ratio, 1.03:1.0). The Ministry of Education operates 9,800 public schools island-wide, and the annual dropout rate is only around 5% to 10% [4].

A recent study found that the prevalence rates of underweight, stunting, and overweight among adolescents attending urban non-national schools were 31%, 3%, and 6%, respectively [5]. At present, the Ministry of Health is responsible for the school health program in public schools. There is no organized program for health education and promotion in schools. Ad hoc health education programs conducted by the Ministry of Health and food supplementation programs conducted by the Ministry of Education are carried out, but there is no sustained effort. Hence it is timely to assess the nutritional problems among adolescents in order to help focus more targeted interventions.

The objectives of this study were to determine the prevalence of nutritional problems (stunting, underweight, overweight, vitamin A deficiency, and anemia) and to assess food-consumption and activity patterns among adolescent schoolchildren aged 10 to 15 years in Sri Lanka.

Subjects and methods

A two-stage cluster sample design was used to draw a nationally representative sample of students 10 to 15 years of age from public school grades 5 to 10 in 2002. The calculated sample size for each district was 372 students, with an expected 20% prevalence of underweight, a 95% confidence interval, and a 5% error. The design effect was 1.5.

Sri Lanka is divided into 25 administrative districts. The first-stage-sampling frame contained 25 primary sampling units (PSU) consist of each district. From the 25 PSUs, 12 schools from each PSU were selected with the probability proportionate to school enrollment size. A total of 144 schools were included. All selected schools were visited by the field workers prior to the survey. The second stage of sampling consisted of random selection of one or two classes from each of the grades 5 through 10 at each school. When there were fewer than 31 children in a class, two classes were included. All students in the selected classes were given a letter and consent form by the class teacher to obtain consent from their parents or guardians prior to the start of the study.

All children from each selected class who had obtained the consent of their parents or guardians were included in the study. All children were examined for the presence of Bitot's spots to detect vitamin A deficiency, and their weights and heights were measured. Five teams of three fieldworkers collected data, covered five schools per day and moved from one district to other. Anthropometric data were collected by five health-care personnel who had previous experience of participating in nutritional surveys, and they were trained before the study. Heights and weights were measured by standard techniques described by the World Health Organization (WHO) [6]. Height was measured with a stadiometer while the subject was not wearing shoes and with the head held in the Frankfort horizontal plane. The subjects were weighed with an electronic Seca scale (Hamburg, Germany) while they were wearing a minimum of clothing and without shoes. The accuracy of the scale was checked each morning by standard weights. Weights and heights were recorded to the nearest 0.1 kg (no corrections were made for the weight of the clothing, which averaged 150 g) and 0.1 cm, respectively. The accuracy of the measurements was assessed by having 10% of the measurements repeated by the same person and 10% by a nutrition assistant. The coefficient of variation of measurement error was 0.1 for weight and 0.2 for height. Age- and sex-specific BMI data were used, as recommended by WHO [7].

Eleven children from each school who had undergone anthropometric assessment were selected with the use of computer-generated random numbers for assessment of hemoglobin levels by Hemocue [Angelholm, Sweden]. Fingerstick blood samples were taken from 1,521 students; hemoglobin levels were measured and age-dependent cut-off values (as defined by WHO) were taken to detect anemia with adjustment for altitude [8].

Every other student who had participated in hemoglobin testing was interviewed to obtain information on food consumption and physical activity patterns during the 7 days prior to the interview. A pretested, standardized questionnaire was used to obtain data on the frequency of consumption of 41 different food items (more than once daily, once daily, once or more than once in the past week, never in the past week). The questionnaire also obtained data on the amount of time spent on different activities, including playing organized games and sedentary activities such as watching television and attending tuition classes ($\leq$ 2 hours per day, > 2 hours per day, 2 to 6 days per week [less than daily], once in the past week, never in the past week).

Age was calculated from the subject's birthday as recorded in the attendance register (11.0 to 11.9 = 11 years, 12.0 to 12.9 = 12 years, etc.) and grouped. Height-for-age percentiles were calculated with ANTHRO software (Centers for Disease Control and Prevention, Atlanta, Ga, USA). The WHO/National Center for Health Statistics (NCHS) reference data for height were used to estimate the prevalence of stunting (height-for-age < 3rd percentile) [7]. The body-mass index (BMI) was calculated as the weight in kilograms

divided by the square of the height in meters. Age- and sex-specific BMI data were used to estimate the prevalence of underweight (BMI < 5th percentile), as recommended by WHO [7]. The age- and sex-specific BMI references proposed in 2000 by the International Obesity Task Force (IOTF) were used to define overweight and obesity for international comparison [9]. Cluster sample analysis was carried out with the Epi Info version 6.0 software package (Centers for Disease Control and Prevention, Atlanta, Ga, USA). Prevalence rates and 95% confidence intervals were calculated. Analysis of variance (ANOVA) and chi-square analyses were performed and odds ratios were calculated. The level of significance was defined as $p < .05$. Ethical approval was obtained from the ethical committee of Medical Research Institute.

Results

A total of 6,264 children aged 10 to 15 years in 144 schools were enrolled in the study. All children had obtained the consent of their parents or guardians. The response rate was 100%. The students were evenly distributed in terms of sex (50.8% boys and 49.2% girls). In this sample there were more children between 10–12 years than 13–15 years because of the age distribution in the smaller schools.

Table 1 shows the mean height, weight, and BMI of the subjects. Girls 11 through 13 years of age were taller than boys of the same age, and girls were heavier than boys on average. Boys were taller than girls at the ages of 10, 14, and 15 years. BMI increased significantly with age in both boys and girls, but the increase was greater in girls ($p < .05$). Girls had significantly higher mean BMI than boys at all ages ($p < .05$). The mean z scores (WHO/NCHS) for both height and weight were between minus one and minus two in all age groups [6].

Prevalence of stunting, underweight, and overweight

The overall prevalence of stunting (< 3rd percentile of NCHS/WHO height-for-age reference) [7] was 28.5%; the prevalence was significantly higher among girls than boys (29.1% vs. 27.9%, $p < .05$; **table 2**) The prevalence of stunting increased significantly with age in boys up to 13 years (21.4% to 41.3%, $p < .05$), except for a slight decrease between the ages of 10 and 11 years. The prevalence of stunting in girls increased significantly between the ages of 11 and 13 years (20.2% to 40.1%; $p < .05$). The highest overall prevalence of stunting (40.8%) was observed at the age of 13 years.

Almost half of the children (47.2%) were underweight (< 5th percentile of reference BMI for age and sex) [7] (**table 2**). The prevalence of underweight was significantly higher in boys than in girls (57.9% vs. 36.1%, $p < .05$). The prevalence of underweight decreased significantly with increasing age in girls (51.7% to 19.7%, $p < .05$) but increased between the ages of 11 and 13 years in boys (56.2% to 66.5%, $p < .05$). The highest prevalence of underweight (66.5%) was observed in boys at the age of 13 years.

The prevalence of overweight was 2.2% overall and was higher ($p > .05$) in girls (2.7%) than in boys (1.7%). The prevalence of overweight was negligible when compared with that of underweight and stunting.

Prevalence of vitamin A deficiency and anemia

All 6,264 students were examined for the presence of Bitot's spots, which were considered to indicate vitamin

TABLE 1. Mean height, weight, and body-mass index (BMI) of schoolchildren according to sex and age ($n = 6264$)

Age (yr)	n	Height (cm)		Weight (kg)		BMI (kg/m^2)
		Mean ± SD	Mean z score ± SD	Mean ± SD	Mean z score ± SD	Mean ± SD
Males						
10	944	132.0 ± 6.1	–1.14 ± 0.97	25.3 ± 4.8	–1.48 ± 0.87	14.5 ± 1.8
11	719	138.3 ± 6.9	–1.21 ± 0.95	28.9 ± 5.7	–1.49 ± 0.85	15.0 ± 1.9
12	785	141.2 ± 6.5	1.41 ± 0.84	30.6 ± 5.9	–1.64 ± 0.81	15.2 ± 1.9
13	230	145.8 ± 7.9	1.59 ± 0.92	32.7 ± 5.9	–1.94 ± 0.76	15.2 ± 1.5
14	254	154.3 ± 8.4	1.45 ± 0.94	38.9 ± 7.7	–1.86 ± 0.87	16.1 ± 2.1
15	248	159.7 ± 7.0	1.42 ± 0.90	43.1 ± 6.9	–1.84 ± 0.81	16.8 ± 2.5
Females						
10	813	131.5 ± 6.5	–1.22 ± 0.91	25.4 ± 4.9	–1.52 ± 0.82	14.6 ± 1.9
11	657	140.0 ± 7.6	–1.19 ± 0.99	30.8 ± 6.4	–1.35 ± 0.87	15.4 ± 2.2
12	846	143.4 ± 7.1	–1.36 ± 0.91	34.1 ± 7.1	–1.28 ± 0.89	16.1 ± 2.6
13	182	146.0 ± 6.5	–1.66 ± 0.70	36.9 ± 6.5	–1.43 ± 0.74	16.7 ± 2.5
14	266	150.9 ± 5.9	–1.49 ± 0.77	39.9 ± 6.6	–1.53 ± 0.78	17.4 ± 2.4
15	320	151.8 ± 5.8	–1.47 ± 0.82	41.9 ± 6.9	–1.57 ± 0.79	18.1 ± 2.4

TABLE 2. Prevalence of underweight, stunting, and overweight among schoolchildren according to age and sex (n = 6,264)

		Age (yr)						
		10 (n = 1,757)	11 (n = 1,376)	12 (n = 1,631)	13 (n = 412)	14 (n = 520)	15 (n = 568)	All ages (n = 6,264)
Characteristic	Sex	% prevalence (95% confidence interval)						
Stunting[a]	Male	21.4 (18.4–24.4)	19.2 (18.1–29.2)	26.6 (24.2–35.8)	41.3 (33.3–49.3)	38.9 (31.9–45.9)	34.3 (27.9–40.7)	27.9 (24.9–30.8)
	Female	23.4 (20.1–26.6)	20.2 (21.8–33.3)	30.9 (26.3–35.4)	40.1 (31.8–48.5)	32.3 (26.9–37.7)	33.1 (26.9–39.3)	29.1 (26.6–31.6)
	Total	22.3 (19.9–24.7)	25.5 (21.6–29.4)	30.5 (25.9–35.1)	40.8 (34.4–47.2)	35.6 (31.2–39.9)	33.6 (29.1–38.1)	28.5 (26.2–30.7)
Underweight[b]	Male	59.9 (56.5–63.4)	56.2 (50.9–61.4)	58.7 (53.9–63.6)	66.5 (60.7–72.4)	52.8 (45.9–59.7)	50.0 (43.1–56.9)	57.9 (55.4–60.5)
	Female	51.7 (48.3–54.9)	39.4 (34.3–44.5)	31.8 (27.9–35.7)	26.4 (19.8–32.9)	20.7 (16.2–25.2)	19.7 (14.2–25.1)	36.1 (33.4–38.9)
	Total	56.1 (53.9–58.4)	48.2 (44.6–51.7)	44.8 (41.0–48.5)	48.8 (43.1–53.9)	36.3 (32.3–40.4)	32.9 (27.3–38.5)	47.2 (45.1–49.3)
Overweight[c]	Male	2.2 (1.6–2.8)	1.8 (-0.2–3.9)	2.4 (1.2–3.7)	0.0	0.0	0.0	1.7 (0.9–2.4)
	Female	2.5 (1.3–3.7)	3.0 (1.5–4.6)	3.5 (2.2–4.9)	0.0	2.6 (0.5–4.7)	2.2 (0.5–3.9)	2.7 (1.9–3.5)
	Total	2.3 (1.6–3.0)	2.4 (1.1–3.7)	3.0 (2.1–3.9)	0.0	1.3 (0.3–2.4)	1.2 (0.2–2.2)	2.2 (1.7–2.7)

a. Height-for-age < 3rd percentile [5].
b. Age- and sex-specific body-mass index (BMI) < 5th percentile [7].
c. BMI percentiles > 25 kg/m^2 (IOTF) [8].

A deficiency (**table 3**). The overall prevalence was 0.4%, with no significant difference between boys (0.4%) and girls (0.3%). A total of 1,521 students (24.2% of the total sample) were tested for anemia. The student response rate to anemia testing was 96.0%. The prevalence of anemia increased with age, except at the age of 11 years, and decreased from 14 to 15 years (**table 3**). The prevalence of anemia was higher ($p > .05$) in boys than in girls except in the 14- and 15-year age group. The overall prevalence of anemia was 11.1%. The highest prevalence of anemia was observed at the age of 14 years (37.7%) among girls, which may be associated with the onset of menstruation.

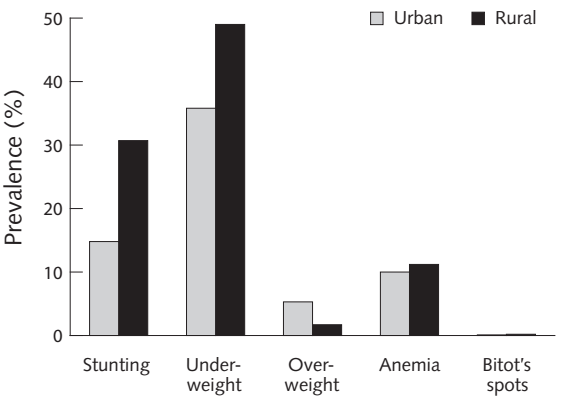

FIG. 1. Prevalence of underweight, stunting, overweight, anemia, and vitamin A deficiency among schoolchildren aged 10 to 15.9 years according to sector. Odds ratios (95% confidence intervals): stunting, 0.4 (0.3–0.5); underweight, 0.6 (0.5–0.7); overweight, 3.2 (2.1–5.2); anemia, 0.9 (0.5–1.5)

Sector variation

The prevalence of stunting and underweight was significantly higher among students from rural schools than among those from urban schools (stunting: 14.8% urban, 30.7% rural, $p < .05$; underweight: 35.8% urban, 49.0% rural, $p = .05$). Conversely, more urban than rural students were overweight (5.3% vs. 1.7%, $p < .05$; **fig. 1**). Anemia was equally prevalent among children from rural and urban schools (11.2% and 10.0%, respectively, **fig. 1**).

Eating patterns

During a regular class period, 787 students were interviewed with the use of a food-frequency questionnaire regarding their food consumption during the previous week, and their responses were recorded directly on an answer sheet. **Table 4** shows that there were substantial differences in the consumption of foods from different groups.

Cereals. The main source of energy was rice. Rice is the staple food in Sri Lanka and was more popular among children than other cereals, including bread,

TABLE 3. Prevalence of anemia and vitamin A deficiency among schoolchildren according to age and sex (n = 1,521)

Age (yr)	n	Mean ± SD Hb (g/dL)	% prevalence (95% CI) of anemia[a]			% prevalence (95% CI) of Bitot's spots			
			Males	Females	Total	n	Males	Females	Total
10	378	12.6 ± 1.4	10.5 (8.7–12.3)	9.6 (7.6–11.7)	10.1 (8.5–11.6)	1,757	0.3 (0.1–0.5)	0.2 (0.0–0.5)	0.3 (0.1–0.5)
11	395	12.8 ± 1.0	8.7 (5.3–12.1)	6.9 (3.7–10.1)	7.8 (5.1–10.5)	1,376	0.6 (0.2–0.9)	0.6 (0.0–1.2)	0.6 (0.3–0.9)
12	421	13.2 ± 1.1	15.1 (7.1–23.1)	11.5 (7.4–15.7)	11.2 (8.3–14.0)	1,631	0.4 (0.0–0.8)	0.3 (-0.1–0.6)	0.3 (0.1–0.5)
13	85	13.1 ± 1.2	12.9 (3.9–21.9)	6.3 (2.4–14.9)	11.8 (5.8–17.7)	412	0.0	0.5 (-0.5–1.6)	0.2 (-0.2–0.7)
14	131	13.6 ± 1.4	22.9 (9.0–36.8)	37.7 (27.6–47.8)	25.9 (18.6–33.3)	520	0.4 (-0.4–1.2)	0.4 (-0.4–1.1)	0.4 (-0.1–0.9)
15	111	13.9 ± 1.3	11.0 (9.6–12.4)	12.7 (5.1–20.3)	17.1 (9.7–24.6)	560	0.4 (0.4–1.2)	0.0	0.2 (-0.2–0.5)
Total	1,521	12.9 ± 1.2	11.0 (9.6–12.4)	11.2 (9.4–13.1)	11.1 (9.9–12.4)	6,264	0.4 (0.3–0.5)	0.3 (0.1–0.5)	0.4 (0.2–0.5)

CI, confidence interval; Hb, hemoglobin

a. Anemia cutoff points (g/dL Hb): 5–11 years < 11.5; 12–13 years < 12.; > 13 years (males) < 13.0; > 13 years (females) < 12.0. Measurements are corrected for altitude [8].

TABLE 4. Frequency of consumption of specific foods by schoolchildren in the 7 days prior to the interview (n = 787)

Food	More than once daily	Once daily	Once or more than once in the past week	Never in the past week
	% of children			
Cereals				
Rice	90.7	9.3	0.0	0.0
Bread	5.7	47.0	26.0	21.3
Other cereals	0.2	3.8	8.6	87.4
Tubers, other starchy foods	0.8	11.4	25.3	62.5
Milk, milk products				
Milk	14.6	31.8	5.1	48.5
Yogurt (unsweetened, made with buffalo curd)	1.0	12.7	18.2	68.1
Butter	0.4	9.3	6.8	83.5
Vegetables				
Green leafy vegetables	3.2	51.9	20.5	24.4
Other vegetables (e.g., beans, pumpkin)	5.4	45.7	25.6	23.3
Fruits	2.1	47.5	23.8	26.6
Animal protein				
Eggs	0.1	18.1	32.3	49.5
Fish	2.5	37.1	27.5	32.9
Chicken	0.5	11.2	20.0	68.3
Pork, beef, sausages	0.5	7.8	7.2	84.5
Vegetable protein				
Soya products	1.7	19.3	27.0	52.0
Dhal	2.7	56.4	25.9	15.0
Sugar, sugary foods and beverages				
Biscuits	2.2	37.3	32.3	28.2
Chocolate	15.2	29.4	18.9	36.5
Cola	0.3	6.6	13.2	79.9
Tea with sugar	33.8	50.5	3.0	12.7

yams, and other starchy foods such as raw jak fruit and breadfruit. More than 90% of the children consumed rice more than once a day.

Milk and milk products. During the preceding week, 48.5% of the children had not consumed milk, and 68.1% had not consumed milk products such as curd and yogurt. Only 46.4% of adolescents drank milk at least once daily.

Vegetables and fruits. Although many fruits flourish in Sri Lanka, 26.6% of the children had not consumed any fruits, and 49.6% of the children ate fruits at least once a day during the week prior to the interview. A similar pattern was observed with the vegetable consumption. During the week, 24.4% and 23.3% of the children, respectively, had not consumed green leafy vegetables or other vegetables. More than half of the children (55.1%) had consumed green leafy vegetables at least once daily during the week prior to the interview.

Animal protein. The most frequently eaten animal foods were fish and eggs. However, 32.9% of the children had not consumed any animal food during the previous week.

Vegetable protein. Lentils (dhal) were popular among children; 59.1% of the children had consumed lentils every day. More than half of the children (52%) had not consumed soya products.

Sugary foods and beverages. The students had consumed biscuits, cakes, chocolates, and other sugary foods. Tea with sugar was consumed daily by 84.3% and more than once a day by 33.8%. Only 6.9% of the students consumed cola drinks daily during the week prior to the interview.

Physical activity patterns

Around one-fifth (19.0%) of the children had not participated in play involving physical activity in the preceding week (**table 5**). With regard to sedentary activities, 27.5% watched television more than 2 hours per day and 17.7% attended daily private classes (**table 5**).

Breakfast habits

Breakfast is an important meal in the Sri Lankan diet, and plays a beneficial role in the performance of schoolchildren. [2]. All of the children who participated in the study were questioned on their breakfast habits before going to school during the last 6 months; 10.4% reported that they usually skipped breakfast before going to school.

Discussion

This study reports the prevalence rates of stunting, underweight, overweight, anemia, and vitamin A deficiency and the patterns of food consumption and physical activity among Sri Lankan adolescent schoolchildren. When considering the findings of this study as national estimates for adolescents, we should be cautious, for two reasons. First, the data apply only to adolescents 10 to 15 years of age attending public schools and therefore do not represent all children in this age group. We must take into consideration, however, that only 5% of Sri Lankan children attend private schools. Second, the results are strictly based on answers that were given by the interviewees, and therefore the extent of underreporting or overreporting of food consumption and activity patterns cannot be determined.

Anthropometric analysis was carried out with the use of BMI values based on the first National Health and Nutrition Examination (NHANES I) in the United States, as recommended by the WHO expert committee [7]. At present the Ministry of Health in Sri Lanka uses this reference for nutritional assessment of schoolchildren during the routine school health program. Therefore, the same reference was used for comparative purposes.

In agreement with previous studies in Sri Lanka [10–13], girls were taller and heavier than boys. Height, weight and BMI data demonstrated that the growth pattern of the adolescents on average was far below the WHO reference standards.

Our finding of a very high prevalence of underweight is particularly striking. Studies in Bangladesh and Calcutta produced similar findings [14]. The high prevalence of underweight may be due to the delayed onset of puberty. The higher prevalence of underweight among boys suggests that their puberty was more delayed relative to their reference data than girls.

Rural students had a higher prevalence of underweight and a lower prevalence of overweight than urban students. This finding has an important programmatic implication. School-feeding programs in rural

TABLE 5. Frequency of participation in physical activities and other activities by schoolchildren during the 7 days prior to the interview (n = 787)

	Frequency of participation (% of children)				
Activity	≤ 2 h/day	> 2 h/day	2–6 days/wk (< daily)	Once in the past week	Never in the past week
Playing	17.2	50.8	8.5	4.5	19.0
Organized outdoor games[a]	6.7	27.0	6.8	2.5	57.0
Being tutored privately	4.1	13.6	24.5	0.8	57.0
Watching television	27.5	50.2	7.1	1.7	13.5

a. Badminton, volleyball, netball, swimming, etc.

schools as well as programs to promote healthy dietary behavior and physical activity to prevent overweight in urban schools should be set up in parallel by the school health program in Sri Lanka in collaboration with the Ministry of Health and Education. The present level of human and other resources in Sri Lanka permits only 60 to 70% of children in grades 1, 4, and 7 to be covered by the school health program. Currently, there is no organized Ministry of Health program to promote adolescent nutrition.

More girls were stunted than boys, the reverse of the situation in most developing countries. The children were less likely to be stunted at younger ages (10 and 11 years), and the prevalence of stunting increased as they entered the period of rapid growth during adolescence. A multicountry WHO study found that the prevalence of stunting among adolescents ranged from 27% to 65% with cutoff points at the 5th percentile; our study found similar values, with cutoff points at the 3rd percentile [3]. It is important to consider the negative effects of stunting, such as impaired cognitive function, especially among this school population. The results further highlight the need for food supplementation, which has resulted in increased catch-up growth among adolescents [14].

The study found that clinical vitamin A deficiency among adolescent schoolchildren is not a nationwide public health problem according to the cutoff points established by WHO/UNICEF/Helen Keller International/International Vitamin A Consultative Group (WHO/UNICEF/HKI/IVACG) [15]; however, the 0.4% prevalence of Bitot's spots indicates there is still a need for further control of vitamin A deficiency. Routine vitamin A megadose supplementation is carried out in Sri Lanka through the school health program for children in grades 1, 4, and 7. The findings of this study indicate the need to extend this program to other age groups also.

Anemia has been considered the greatest nutritional problem among adolescents [2]. The prevalence of anemia in this study (11.1%) was less than that in other developing countries (27%) [14]. While overall prevalence of anemia was equal for girls and boys, it was significantly different between boys and girls of the same age. The highest prevalence of anemia was found among girls 14 years of age, which may be due to the onset of menstruation. Although this finding should be interpreted cautiously because of the wide confidence interval, it highlights the need for a suitable program to control anemia.

The food-frequency questionnaire was not validated by other methods of dietary assessment in children. All of our data on dietary and physical activity were based on a representative subsample of children. According to the study findings, during the previous week one-fourth of the children had not consumed fruits, which play a vital role in providing a diversified and nutritious diet [16]. Consumption of animal products was also low. These dietary data are consistent with the nutritional status of the children in this study. In Sri Lanka, the cheapest foods in the market are green leaves, and fruits are plentiful throughout the year. Cancer and heart disease are among the 10 leading causes of hospitalization in Sri Lanka. Children and parents should be made aware of the value of consuming fruits and green leafy vegetables. This will further help to control anemia and vitamin A deficiency among adolescents.

Conclusions

This study documented a high prevalence of underweight and stunting and a low prevalence of overweight in Sri Lankan adolescent schoolchildren aged 10 to 15 years. Anemia and, to a lesser extent, vitamin A deficiency should be addressed by school health programs. Our findings regarding underweight and anemia among adolescent schoolchildren were somewhat alarming. The Ministry of Health and Ministry of Education has a challenging agenda to conduct relevant nutrition programs to address underweight among adolescents. We recommend that awareness be created among children, teachers, and parents about food diversity, eating practices, and the adverse effects of underweight and anemia, especially as they relate to educational achievement.

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Evidence-based nutrition recommendations for the treatment and prevention of type 2 diabetes and the metabolic syndrome

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Nutritional recommendations for the prevention and management of diabetes and other diseases were in the past based principally upon the opinion of "expert" committees. Leading clinicians and researchers who served on such committees were expected to base their advice on their own clinical experience or research, or that of others known to them. More recently, in parallel with the development of evidence-based medicine [1], nutritional management must be based on evidence-based nutrition. This involves a prescribed method for searching the relevant literature using an agreed set of descriptors and relevant data banks (e.g., Medline, Embase). Individual studies are evaluated according to specified criteria and assigned to one of five evidence classes (**table 1**) according to the type and quality of the study. Recommendations themselves are graded according to the strength of the evidence. Grade A recommendations are based on evidence of class Ia or Ib, which require meta-analyses of randomized, controlled clinical trials, or at least one appropriately conducted randomized, controlled trial. Ideally, evidence-based guidelines are based upon trials with fatal or nonfatal clinical endpoints. Given the complexities of large-scale nutritional intervention studies, which are required to produce such clinical endpoints, it is often necessary to base recommendations on surrogate endpoints. Surrogate endpoints relevant to the management of diabetes are shown in **table 2**. In the past 4 years, there have been several randomized, controlled trials that have examined the role of lifestyle modification in the prevention of diabetes among persons at high risk who have already developed impaired glucose tolerance. Thus it has been possible to generate evidence-based recommendations for the prevention as well as the management of type 2 diabetes. Randomized, controlled trials that have examined potential agents for the prevention of type 1 diabetes have not confirmed the potential of any of the agents tested to reduce risk. The Diabetes and Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (EASD) has recently published its guidelines derived from evidence-based nutritional approaches to the treatment and prevention of diabetes mellitus [2], upon which this review is largely based.

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Energy balance and body weight

An overwhelming body of evidence justifies grade A recommendations to reduce energy intake and increase energy expenditure among those who are overweight and to prevent weight regain once weight loss has been achieved. Insulin sensitivity is reduced and most of the metabolic abnormalities associated with diabetes are exaggerated in those who are overweight [3]. Even modest weight loss (of less than 10% body weight) improves insulin sensitivity and glucose tolerance and reduces lipid levels and blood pressure [4].

There is evidence to suggest that for European populations the appropriate body-mass index (BMI) range for people with diabetes should be the same as that for nondiabetic persons (18.5–25 kg/m^2) [5, 6], though for other population groups a somewhat different range may be more appropriate [7] (e.g., for those of Indian descent, a lower range may apply). The life expectancy of overweight people with diabetes is improved in those who lose weight and may even be normalized without the patient's achieving a BMI of less than 25 kg/m^2 [8]. Overweight patients with type 1 diabetes may also become insulin resistant, and weight loss may lead to a reduction in insulin dose and improved glycemic control [9]. Other recommendations regarding the most appropriate ways of achieving weight loss are graded as C (see **table 1**), since they are based on expert opinion rather than sound experimental evidence.

TABLE 1. Evidence classes and grades of recommendations suggested by the Scottish Intercollegiate Guidelines Network (SIGN)

SIGN statements of evidence		SIGN grades of recommendations	
Ia	Evidence obtained from meta-analysis of randomized controlled trials	A	Requires at least one randomized controlled trial as part of a body of literature of overall good quality and consistency addressing the specific recommendations (Evidence levels Ia, Ib)
Ib	Evidence obtained from at least one randomized controlled trial		
IIa	Evidence obtained from at least one well-designed controlled study without randomization	B	Requires the availability of well-conducted clinical studies but no randomized controlled trials on the topic of recommendation (Evidence levels IIa, IIb, III)
IIb	Evidence obtained from at least one other type of well-designed quasi-experimental study		
III	Evidence obtained from well-designed nonexperimental descriptive studies, such as comparative studies, correlation studies, and case studies		
IV	Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities	C	Requires evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities. Indicates an absence of directly applicable clinical studies of good quality (Evidence level IV)

Dietary protein

Recommendations regarding dietary protein have long been controversial, with conflicting advice regarding amount and quality from different authorities. A meta-analysis [10] of randomized, controlled trials of up to 3 years' duration in patients with type 1 diabetes and nephropathy [11–14] found that a low-protein diet significantly slowed the development of albuminuria and the decrease of glomerular filtration rate. The most recent randomized, controlled trial published subsequent to the meta-analysis involved 82 patients with nephropathy and was the longest carried out thus far (4 years). In this trial, the patients with type 1 diabetes assigned to the low-protein treatment (target intake, 0.6 g/kg/day; achieved intake, 0.89 g/kg/day) had a strikingly improved outcome (relative risk for end-stage renal disease or death after adjustment for cardiovascular risk factors, 0.23) in comparison with those assigned to the usual protein intake (1.2 g/kg/day) [15]. Thus, restriction of protein intake to the lower end of the acceptable range (0.8 g/kg normal body weight/day) is recommended for diabetic nephropathy in type 1 diabetes (grade A recommendation). Severe protein restriction is not recommended, since patients with diabetes, especially those whose diabetes is poorly controlled or who are on hemodialysis, have increased protein turnover, and their protein requirements may be greater than the recommended daily allowance (RDA) [16]. Thus, protein intake should not be reduced below 0.6 g/kg normal body weight/day, because such reduction may lead to malnutrition.

TABLE 2. Surrogate endpoints used in nutritional studies involving people with diabetes

Glycemia	Fasting plasma glucose Postprandial plasma glucose Glycated hemoglobin (HbA_{1c})
Body composition	Adiposity Body weight Body-mass index (BMI) Waist circumference
Lipoprotein profile	Total cholesterol LDL cholesterol HDL cholesterol Triglyceride
Blood pressure	
Insulin sensitivity	Fasting insulin Postprandial insulin Insulin sensitivity index (ISI) Whole-body glucose disposal
Renal function	Microalbuminuria Proteinuria Glomerular filtration rate

For patients with type 1 diabetes and incipient nephropathy (microalbuminuria) and those with type 2 diabetes and established or incipient nephropathy, there is insufficient evidence to make a firm recommendation regarding protein restriction. For these patients, and for all patients with diabetes without nephropathy, it seems appropriate for protein to contribute between 10% and 20% of total energy, the range for most Western populations. Replacing red meat with chicken, fish, or vegetable protein has been shown to be associated with reduced glomerular filtration rate and a reduced albumin excretion rate in patients with elevated glomerular filtration. However, the studies have been relatively short term and the results inconsistent, and they are therefore not a basis for making recommendations [2].

Dietary fat

Given the appreciably increased risk of cardiovascular disease in diabetes, it is hardly surprising that recommendations regarding dietary fat are similar for people with diabetes and those at risk for cardiovascular disease for other reasons [2]. However, a grade A recommendation to reduce saturated fatty acids and trans-unsaturated fatty acids to below of 10% total energy (or below 8% if low-density lipoprotein [LDL] cholesterol is raised) is justified not only because of the established benefit in terms of reducing cardiovascular risk [17], but also because of the effects of these fatty acids on insulin resistance and the increased insulin sensitivity noted when saturated fatty acids are replaced by cis-unsaturated fatty acids [18–20]. Although the recommendation that a wide range of monounsaturated fatty acids is acceptable achieves only grade B status, this advice is important because it permits considerable flexibility in terms of both carbohydrate and total fat intake, provided that total fat intake does not exceed 35% of total energy. The maximum total fat intake is based upon the energy density of high-fat diets and possible adverse effects on insulin sensitivity. N-6 polyunsaturated fatty acids have beneficial effects on lipids and lipoproteins when substituted for saturated fatty acids, but as in the case for nondiabetic persons, it is recommended (grade C recommendation) that intake not exceed 10% of total energy because of the increased risk of lipid peroxidation possibly associated with higher levels of intake. Regular consumption (at least twice weekly) of fish (preferably oily) and plant sources of n-3 fatty acids (e.g., rapeseed oil, soybean oil, nuts, and some green leafy vegetables) helps to ensure an adequate intake of n-3 polyunsaturated fatty acids (grade B recommendation). Restriction of dietary cholesterol to 300 mg or less per day, especially in the presence of raised LDL cholesterol (grade A recommendation), is based on evidence from diabetic [17, 21] as well as nondiabetic persons.

Total carbohydrate, glycemic index, dietary fiber, and free sugars

Advice regarding carbohydrates has varied over the years, ranging from carbohydrate restriction to the recommendation of high-carbohydrate diets. It is now clear that the quality rather than the quantity of carbohydrate is what really matters. Vegetables, legumes, fruits, and whole-grain cereals are the most appropriate sources of carbohydrate; a meta-analysis [22] suggested that a wide range of intakes (from 45% to 60% of total energy) is compatible with comparable glycemic control. Naturally occurring foods that are rich in dietary fiber are strongly recommended, with a total dietary fiber intake of 40 g/day (or 20 g/1,000 kcal/day) or more being ideal. This grade A recommendation is based on randomized, controlled trials in type 1 and type 2 diabetes [23, 24]. However, beneficial effects are also obtained with lower and, for some, more acceptable amounts. About half of total dietary fiber should be soluble. Such diets not only improve glycemic control but also result in reduced levels of total and LDL cholesterol [25] and increased levels of high-density-lipoprotein (HDL) cholesterol [26]. Many foods that are high in dietary fiber, especially soluble fiber, also have a low glycemic index. However, regardless of fiber content, a meta-analysis [27] has reported that among subjects with diabetes, the percentage of hemoglobin A_{1c} is, on average, 0.43% lower in those consuming a diet of low-glycemic-index foods than in those consuming a diet of high-glycemic-index foods. Although this effect is smaller than that which has been observed with some other dietary interventions, it should not be considered trivial, since it was achieved over and above the other dietary changes aiming to improve glycemic control, such as increased dietary fiber and reduction in body weight. Thus, it is appropriate to make a grade A recommendation that carbohydrate-rich, low-glycemic-index foods are suitable as carbohydrate-rich choices provided other attributes of these foods are appropriate. This caveat is essential, since some low-glycemic-index foods (e.g., ice cream) may be energy dense because they are high in fat and sugars.

Moderate intakes of free sugars (up to 50 g/day) may be incorporated, if desired, within the diets of persons with type 1 or type 2 diabetes (grade A recommendation), provided blood glucose levels are acceptable and the person is not overweight [28–30]. Randomized, controlled trials have been undertaken which suggest that glycemic control, lipids, and lipoproteins are not adversely affected by such amounts of sugar. In persons with insulin resistance, a high intake of free sugars may be associated with hypertriglyceridemia [31]. The wide acceptable range of intakes of total carbohydrate means that personal and cultural preferences can play an important role in determining intakes, which in turn enhances compliance. However, for some, metabolic characteristics may also suggest the most appropriate intake within this range. For those who are insulin resistant and hypertriglyceridemic, intakes at the lower end of the range might help to lower triglyceride levels as well as improve glycemic control. It is also particularly important for such persons to emphasize foods that are rich in dietary fiber and have a low glycemic index [32–34]. A range of grade C recommendations helps to facilitate the choice of carbohydrate-containing foods of appropriate quality.

Antioxidant nutrients, vitamins, minerals, and trace elements

Sodium restriction has been shown to produce substantial reduction in systolic blood pressure in hypertensive patients [35] and to enhance the blood pressure–lowering effect of other dietary manipulations (low-fat dairy products, fruits, and vegetables), hence the grade A recommendation to restrict salt to under 6 g/day, with the possibility of further restriction for those with elevated blood pressure. Although no conclusive evidence exists for people with diabetes, grade C recommendations are offered regarding the encouragement of foods naturally rich in dietary antioxidants, trace elements, and other vitamins. This is achieved by daily consumption of a range of vegetables and fruits and regular consumption of whole-grain breads, cereals, and oily fish. There is no convincing evidence for the benefit of dietary supplements.

Prevention of diabetes

Prospective studies have shown an increased risk of developing type 2 diabetes in those who have a high proportion of saturated fatty acids in their plasma lipid esters compatible with a high dietary intake of saturated fat [36]. Conversely, those who exercise regularly, are not overweight [37], and who have a high proportion of linoleic acid [38] have a reduced risk of developing type 2 diabetes. High intakes of dietary fiber (especially cereal fiber) and low-glycemic-index foods are also associated with a lower risk of developing the condition. Several randomized, controlled trials in China [39], Finland [40], India (Ramachandran A, personal communication), and the United States [41] have shown that a lifestyle intervention program involving dietary modification and increased physical activity can substantially reduce the risk of progression from impaired glucose tolerance to type 2 diabetes. Weight reduction of 5% to 7% of initial body weight or a weight loss of 5 to 10 kg, depending upon the degree of obesity, appears to be the pivotal component of the protective lifestyle regimen, hence the grade A recommendation regarding weight reduction and maintenance of weight loss in overweight persons. All the intervention trials were based on a macronutrient composition that included a relatively low intake of total and saturated fat (less than 30% and 10% of total energy, respectively) and a moderate to high intake of dietary fiber (> 15 g/1,000 kcal/day), and therefore such a dietary composition is also strongly recommended (grade A). Reduction of intake of energy-dense foods and frequent ingestion of whole-grain products, vegetables, fruits, low-fat meat and milk products, and soft margarines and vegetable oils rich in mono- and polyunsaturated fats are the means of facilitating such a macronutrient composition and achieving weight reduction. Physical activity of at least moderate intensity (e.g., brisk walking) for at least 30 minutes each day is an important component of lifestyle modification aimed at reducing the risk of type 2 diabetes, and together with an increased intake of dietary fiber has been shown to make a contribution to risk reduction that is independent of weight loss. A similar exercise and dietary regimen has been shown to improve insulin sensitivity in insulin-resistant persons prior to the development of impaired glucose tolerance [42]. It seems highly likely that the traditional Mediterranean diet and other traditional dietary patterns may be equally appropriate for achieving risk reduction, provided weight loss in those who are overweight or obese is achieved, though they have not been similarly tested in randomized, controlled trials. Regular vitamin D supplementation or a high dietary intake of vitamin D [43] among young children, a high intake of magnesium [44], and treatment with nicotinamide have been linked with a reduced risk of developing type 1 diabetes. However, clinical trials have not confirmed the beneficial effect of nicotinamide [45], and the absence of clinical trials relating to increasing intakes of vitamin D and magnesium precludes recommendations.

Given the existence of nutritional recommendations firmly based on experimental evidence, the challenge now is to develop strategies that will facilitate their implementation in those at risk of developing diabetes in order to reduce the chances of developing the full-blown condition, and in those who have already developed diabetes to reduce the risk of complications.

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Agricultural biodiversity, nutrition, and health: Making a difference to hunger and nutrition in the developing world

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Abstract

Background. *In spite of the strides made globally in reducing hunger, the problems of micronutrient deficiencies and coexisting obesity and related cardiovascular and degenerative diseases constitute a formidable challenge for the future. Attempts to reverse this trend with single-nutrient intervention strategies have met with limited success, resulting in renewed calls for food-based approaches. The deployment of agricultural biodiversity is an approach that entails greater use of local biodiversity to ensure dietary diversity.*

Objective. *To outline a new strategy proposed by the International Plant Genetic Resources Institute (IPGRI) that employs agricultural biodiversity as the primary resource for food security and health.*

Methods. *The authors carried out a meta-analysis to review and assemble existing information on the nutritional and healthful properties of traditional foods based on a diverse set of case studies and food composition and nutritional analysis studies. The methods highlight particular examples of foods where analysis of nutrient and non-nutrient composition reveals important traits to address the growing problems of malnutrition associated with the rise of chronic diseases. Finally, the authors analyze social, economic, and cultural changes that undermine the healthful components of traditional diets.*

Results. *Based on this multidisciplinary and comparative approach, the authors suggest a holistic food-based approach that combines research to assess and document nutritional and healthful properties of traditional foods, investigating options in which nutritionally valuable traditional foods can contribute to better livelihoods, and ways that awareness and promotional campaigns can identify healthful components of traditional diets that fit the needs of urban and market-oriented consumers.*

Conclusions. *There is an urgent need for agricultural research centers, national agricultural research systems, universities, and community-based organizations to work together under a shared policy framework with the aim of developing a strong evidence base linking biodiversity, nutrition, and health. Although these initiatives are still ongoing, the gains realized in small-scale and local pilot efforts have encouraged IPGRI to work with local partners toward the implementation of scale-up efforts in various regions.*

Key words: Agricultural biodiversity, dietary diversity, micronutrient deficiency

Introduction

Great strides in reducing hunger through increases in cereal productivity have been made worldwide [1], but a 2003 report from the Food and Agriculture Organization (FAO) indicated that although there was a relative decline between 1970 and 1995 in the number of hungry people in developing countries, some 840 million people remained chronically underfed [2]. During the same period, there was also a significant drop globally in the number of malnourished children [3], although in sub-Saharan Africa the number of malnourished children actually increased from 18.5 million to 32.7 million. In the light of such statistics, there is a need for a new approach to the global problems of hunger and malnutrition if the first of the Millennium Development Goals—halving poverty and hunger by 2015—is to be achieved.

In earlier years, the widespread availability of food calories resulting from increases in cereal productivity was critical for the rapid decline in the number of hungry people, particularly in developing countries.

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However, today the availability of high-energy cereal staples is implicated in the nutrition transition phenomenon [4, 5]—the emergence of simplified diets, lack of dietary diversity, and attendant health consequences, such as obesity and hypertension. Thus, hunger and malnutrition coexist today with obesity and obesity-related cardiovascular and degenerative diseases. In the Caribbean Islands [4] and in several developing countries [6], the change in dietary patterns is a major cause of an "obesity epidemic" and its associated changes in disease patterns. Thus, several developing countries now face the double challenge of undernutrition and overnutrition [6].

The narrowing of the food base is a global phenomenon [7–9]. However, of the more than 80,000 plant species available to humans, only three (maize, wheat, and rice) supply the bulk of our protein and energy needs. As a result of this overdependence on too few species, many food plants have been forgotten or neglected, while others require more research on their potential to contribute macro- and micronutrients to the diets of some populations. Nonetheless, Grivetti and Ogle [10] argue that a significant number of these neglected food plants are still important for meeting the macro- and micronutrient needs of developing country populations in particular. These resources are indispensable in reversing what Demment and colleagues [5] describe as a poverty-micronutrient-malnutrition trap in developing countries. The vital role these neglected indigenous food plants play in the traditional food systems of developing countries was emphasized earlier in the World Declaration and Plan of Action for Nutrition adopted at the 1992 International Conference on Nutrition [11]. The Declaration recommended the promotion of dietary diversity and the use of locally available nutrient-rich indigenous and traditional foods as a vital strategy against food insecurity, malnutrition, and disease.

The joint recommendation from the World Health Organization (WHO) and FAO [12] on diet, nutrition, and the prevention of chronic diseases and the more recent recommendation on increased consumption of fruit and vegetables for health [13], reaffirm the urgent need for a global change to dietary diversification. For populations in developing countries, this strategy would entail a significant move toward the greater use of local biodiversity, which engenders good nutrition and ensures diverse and balanced diets. The International Plant Genetic Resources Institute (IPGRI) proposes a new kind of intervention—a mobilization of indigenous and traditional food resources to ensure food security and improved health in the developing world. This strategy contrasts with the single-nutrient interventions that have characterized global food and nutrition intervention programs. This paper considers the use of agricultural biodiversity to improve dietary diversity within the context of other nutrition interventions and to change global patterns of diet and disease. It emphasizes the contributions of nutrients and biologically active non-nutrients in cultivated and wild plants to healthy diets and discusses scientific issues important for further assessing and optimizing this potential. The paper also outlines IPGRI's efforts and experience in building the evidence base linking biodiversity and nutrition, and finally it summarizes components of the suggested strategy in policy and practice.

Previous global nutrition interventions

Nutrition interventions in developing countries can be described as piecemeal, fragmented, and single-nutrient-oriented. This approach may in part be attributed to a lack of knowledge in earlier years of the interactions among nutrients in human physiology and metabolism. Thus, from the report of kwashiorkor by Cicely Williams [14] and the various recommendations for high-protein diets [15, 16] and later for high-carbohydrate diets [17–19], to more recent efforts directed at the elimination of micronutrient deficiencies [20–22], attention generally concentrated on a single nutrient at a time.

The adverse effects of deficiencies of iodine, iron, vitamin A, and other micronutrients gained prominence as more sensitive assay techniques and better epidemiologic tools became available. The roles of micronutrients in health and well-being and the synergies in their physiologic functions are now being increasingly recognized, supporting the notion that micronutrient deficiencies rarely occur in isolation and calling for dietary diversification and nutritional interventions to be food based [11].

Dietary diversity interventions

In recent years, a limited number of successful dietary diversification interventions against vitamin A deficiency have been reported. In Bangladesh [23], a homestead gardening program promoted increased production and consumption of β-carotene–rich fruits and vegetables and achieved a 60% increase in consumption by participating households. A similar project in India [24] also achieved increased consumption of β-carotene–rich vegetables among participating households, with 40% of these households selling their excess produce. Likewise, in Tanzania [25], a combined program of home gardening and nutrition education resulted in a 66% increase in the production of β-carotene–rich fruits and vegetables and a commensurate increase in daily consumption of these fruits and vegetables by the children in the intervention households. Although these latest intervention strategies are food

based, it is of note that they are all designed to address only the problem of vitamin A deficiency.

Although it is generally believed that poverty is a major determinant of nutritional deficiency [26], farming system interventions have not effectively documented the way in which the use of indigenous crops by poor communities can simultaneously achieve the outcomes of micronutrient adequacy, poverty reduction, and biodiversity conservation. Studies linking income generation and conservation [27] typically do not include a nutritional assessment component. Attempts at promoting dietary diversification, particularly with the active involvement of women [28, 29], that have been found effective in controlled pilot-study settings have rarely been scaled up to community levels. Thus, in spite of ample evidence for the positive nutritional and health impacts of dietary diversification, there has been some degree of resistance to large-scale implementation of such types of programs. Underwood [30] cites lack of political commitment as partly responsible for the underutilization of available local food resources as a solution to an identifiable problem. However, Ruel and Levin [31] argue that the lack of direct scientific evidence for the effectiveness of dietary diversification strategies poses serious impediments to making a convincing case in support of large-scale implementation programs. Nevertheless, Kuhnlein [32] affirms that dietary diversification offers the best option for long-term sustainability of food resources in communities. This is especially true when traditional knowledge and sociocultural values are nurtured and a community embraces the targeted behavioral changes.

Changes in dietary patterns and their consequences

Changes in food habits have long been reported to reduce dietary diversity among developing country populations [9, 33]. Furthermore, warnings and reports about the nutritional consequences of the change to simplified diets and the dependence on cereals and cereal products are not new [34, 35]. Delgado and Rearden [35] implicated urbanization and changing lifestyles in changing dietary patterns. With urbanization come changes in employment patterns, particularly for women, which increase the opportunity cost of women's time due to involvement in hired labor or self-employment away from home. The absence of women from their homes for a large portion of the day leads to replacement of traditional foods by "convenience" foods, the most popular being easy-to-prepare cereals such as rice. Welch and Graham [1] reported that since 1970 cereal production in South Asia has increased by more than four times, while the production of micronutrient-rich pulses has declined by approximately 20%. As per capita energy intake has increased, iron intake has declined and the incidence of iron-deficiency anemia has increased.

Locally available indigenous and traditional foods are replaced in the diet by crops such as maize, wheat, rice, and potatoes. Smith [36] reported that in West Africa indigenous foods such as cereals in particular generally require some form of processing before their final use in food preparation. Traditional food-processing techniques are tedious and time consuming, and many traditional meals involve lengthy preparation and cooking. Nutrient-rich sorghum, millet, and hungry rice (*Digitaria exilis*), for example, take more time to prepare than the preprocessed exotic rice that is readily available in local markets. Thus, more and more African women who seek to increase the family income by working outside the home resort to easy-to-cook rice in preference to indigenous foods.

Other factors have contributed to the move from diversified to simplified diets. Johns [37] observed that high-input agriculture, reduced transportation costs, and agricultural subsidies have combined to make refined carbohydrates (wheat, rice, and sugar) cheaper than ever in cities of the developing world. Here fried "street foods" are often the most important dietary item for many poor people. Documentary evidence for such changes is sporadic [37] but can be seen in snapshots of national dietary patterns such as those in Kenya and Senegal, where there has been a shift away from locally important cereals, such as millets, which are known to be better than other cereals, such as maize and rice, for the regulation of blood glucose levels and are also high in iron [37]. In Kenya, there has been a drop in the average intake of pulses and legumes that almost exactly mirrors the increase in daily energy requirements supplied by fats and oils. A similar pattern is observed in Senegal, where oils and fats contributed 20% of daily energy requirements in 1998, up from 8% in 1963. Reports from the Caribbean [4] also implicate the increased availability of dietary fats and sugars in the transition to simplified diets. An irony of the nutrition transition is that it is linked to globalization through trade and the influence of Western culture at a time when medical science is beginning to question the wisdom of the energy-rich diet of affluence. In the developing world, people gravitate to fashionable "modern" foods while abandoning traditional diets that are considered a sign of backwardness and poverty. Ironically, in industrial societies people increasingly look to traditional diets such as those of East Asia and the Mediterranean as embodiments of good nutrition for health.

Health benefits of biodiversity and the consequences of changes in dietary composition

The consequences of the nutrition transition from pulses, fruits, and vegetables to simplified diets devoid of micronutrients and non-nutrient bioactive protective components pose enormous health and development challenges. The cumulative effects of micronutrient malnutrition established early in life limit educational progress, work productivity, and life expectancy [5]. At the population level, the ability of people to participate in economic activities is reduced, and this situation is further complicated and worsened by the burden on national health systems of the pandemic of obesity coexisting with malnutrition [4, 6].

The well-known effects of micronutrient deficiencies—in particular of vitamin A, iron, and zinc [21, 22, 38–40]—are increasingly being linked to the lack of dietary diversity [10, 24, 41, 42]. Dietary shifts that characterize urban and periurban communities now extend to rural communities. For populations in rural areas, this shift to processed cereal-based diets similar to those of industrial countries represents a breakdown in the traditional food systems and safety nets. Lowering the intake of green and yellow vegetables and fruits also results in a reduction of the physiological benefits of non-nutrient phytochemicals. Epidemiologic evidence links intakes of carotenoids and other dietary polyphenols, for example, with reduced cancer risks [43–46], and their antioxidant properties may protect against other chronic diseases such as cardiovascular disease, diabetes, macular degeneration, and neurodegenerative disorders [47–51].

Johns and colleagues [52] noted that the important roles played by plant sterols, omega-3 fatty acids, and other dietary components in reducing diseases have been established largely through the initial study of traditional diets that are associated with longevity and good health. For example, Maasai pastoralists routinely eat almost double the recommended amounts of animal fats and consume more than 25 plant products that contain antioxidants more powerful than the well-known vitamins C and E. This dietary pattern is reflected in a low incidence of cardiovascular diseases in this population.

Functional health benefits are likely factors in the observed lower risk of mortality in older women, as well as greater longevity and reduced incidences of cardiovascular disease, diabetes, and cancer among subjects who consume more diverse diets, as reported in prospective epidemiologic studies in the United States [51, 53]. Similar findings reported from other parts of the world [54, 55] provide convincing evidence of the nutrition and health benefits of dietary diversity.

A new kind of intervention: Mobilizing agricultural biodiversity to ensure dietary diversity

Although there has been a relative shift in food and nutrition intervention strategies from targeted one-nutrient supplementation to food-based approaches, the bulk of these food-based interventions are in effect aimed at the alleviation of vitamin A deficiency and, to a lesser extent, iron deficiency. In view of current knowledge of synergies in the physiologic functions of nutrients, the focus of interventions needs to be on improving overall diet quality while at the same time improving the well-being of rural and urban populations. This new kind of intervention thus aims to employ agricultural biodiversity as a primary resource for food security and health. It entails the revitalization and mobilization of indigenous and traditional food systems and a reintroduction into diets of indigenous staples and nonstaples known to be rich sources of micronutrients and non-nutrient bioactive phytochemicals. A food-systems approach that supports the production and consumption of agricultural biodiversity would involve components such as agricultural extension, promotion, and marketing; nutrition education; and policy development.

Enhancing the knowledge base on traditional foods

Clearly, for this strategy to succeed, knowledge of the foods that are part of the traditional food systems is imperative. One of the root causes of the poor results that are often reported with food-based interventions is lack of knowledge about available indigenous and traditional foods. There is a dearth of taxonomic and nutritional information on these foods, and therefore they are hardly considered by international agencies in global food and nutrition initiatives. Delisle and colleagues [56] lamented the disheartening lack of knowledge of plant sources of β-carotene among decision makers and health workers in the field. The general ignorance of the nature and use of these nutrient-rich and health-protecting indigenous and traditional foods has resulted in their being left out of most local strategies to solve problems of food security and nutrition among rural populations.

Making use of indigenous knowledge

Farmers, however, have the knowledge. There is evidence that indigenous communities recognize the health benefits of some of these food crops that are part of their traditional food systems. They are well aware of cultivar-specific differences in agronomic and dietary

attributes [57, 58], and they often describe certain cultivars or indigenous varieties as having particular nutritional or therapeutic value. Ethiopian farmers have identified at least three indigenous varieties of sorghum that contain about 30% more protein and 50% to 60% more lysine than other varieties [58]. The farmers recognize these varieties as valuable for sick children and nursing mothers. The Luo people of western Kenya recognize the nutritional and therapeutic properties of indigenous leafy vegetables [59]. *Solanum nigrum* is an important component of the traditional diet in this community, but it is also consumed to protect against gastrointestinal disturbances caused by the protozoan parasite *Giardia lamblia*. With its traditional involvement in farmer-participatory variety selection, IPGRI is well placed to combine this type of indigenous knowledge with new technology to advance the selection and mainstreaming of indigenous and traditional foods. However, for these food crops to be mobilized and mainstreamed into global food systems, there are obvious agronomic, taxonomic, and nutritional analytical challenges, as well as an imperative to identify ideal ways in which to quantify the nutritional and health benefits of dietary diversity.

Need for more information and nutrition education on local biodiversity

The pressing need for information on indigenous foods is reflected by the persistent calls of nutritionists, food scientists, and health workers [60–64] for these much-needed data to be made available. As noted by McBurney and colleagues [60], if "wild" food plants are to be utilized to enhance dietary diversification and food security, sound empirical data must be available to researchers and program implementers. Published research on indigenous food plants requires correct taxonomic identification, chemical analysis, and nutritional data; otherwise, the results cannot be interpreted correctly and fully.

Information, education, and communication strategies and the social marketing of programs and products have been found to be indispensable components of successful micronutrient intervention programs [23–25, 28, 29]. A Tanzanian nutrition intervention project [28] found that nutrition education had a greater effect on the main nutrition outcome than the primary strategy of provision of solar dryers for processing β-carotene–rich fruits and vegetables. Through information and culturally applicable nutrition education, community mobilization has the important effect of raising awareness of the links among local food diversity, nutrition, and health by community members. Commenting on the Tanzanian study, UNICEF [65] noted that the success achieved in reducing infant malnutrition in the community suggests that an overall lack of food was not the major cause. The program did not increase the production or availability of basic foods; what it did was to increase awareness of available food resources and empower communities to make good use of local biodiversity.

Growing attention to the value of agricultural biodiversity in diets

Scientific data are emerging on the nutrient and nonnutrient bioactive attributes of some indigenous foods, and there has also been a fresh look at previously available but ignored data on the nutritional composition of some of these foods. Data from Mauritius [64, 66], Micronesia [67], and parts of Africa [67–69] are now beginning to show the immense nutritional properties of indigenous and traditional foods.

For a long time, indigenous leafy vegetables were not considered good dietary sources of micronutrients, but with the increased understanding of nutrient–nutrient interactions [52, 70], they are now being acknowledged as providing significant amounts of vitamins and minerals in traditional diets. In addition to supplying a sizable proportion of the minerals in daily diets (**table 1**), African leafy vegetables can also contribute significantly to daily requirements of vitamin A (**table 2**). Recent reports [69] show that these vegetables contain significant amounts of antioxidants, even after undergoing the traditional processing technique of drying. Data are also available on the phenolic content and antioxidant activities of some indigenous sorghum cultivars (**fig. 1**).

Like leafy vegetables, food condiments and spices are indispensable components of African diets. Spices have recently been reported to have antioxidant and insulin-modulating properties [74, 75]. Kelble [74] reported that antioxidant activity is a common denominator among the spices studied, and the phytochemicals present improve insulin activity. Srinivasan [75] reviewed not only the antidiabetic influence of spices but also their anti-inflammatory, antimutagenic, and anticarcinogenic potentials. There is a dearth of information on the nutritional and chemical properties of sauce condiments and spices used in sub-Saharan Africa, but the available data (**table 3**) indicate that their use on a daily basis, as is the custom in traditional African cuisine, could contribute to the daily intakes of iron, zinc, and calcium. It is thus heartening that many scientists are showing renewed interest in the identification and nutritional analysis of indigenous and traditional food plants [77–81].

Assessing dietary diversity

In making the case for dietary diversity and health, con-

TABLE 1. Zinc, iron, and calcium contents of some African leafy vegetables[a]

Vegetable	Local English name	Zinc (mg/100 g)	Iron (mg/100 g)	Calcium (g/100 g)
Gnetum africanum	None	0.6	6.1	0.24
Corchorus olitorius	Bush okra	0.6	2.2	0.15
Corchorus oliterius	Bush okra	0.6	4.2	0.16
Celosia argentea	Lagos spinach	0.5	3.5	0.09
Cucurbita pepo	Pumpkin leaf	0.8	10.1	0.07
Telferia occidentalis	Fluted pumpkin leaf	1.3	8.4	0.16
Talinium triangulare	Waterleaf	0.3	2.0	0.14
Struchium sparganophora	None	1.4	6.2	0.20
Basella alba	Vine spinach	0.5	1.7	0.28
Solanum melongena	Spinach	0.4	2.4	0.16
Solanum aethiopicum	Spinach	0.6	6.1	0.14
Solanum macrocarpon	Spinach	0.7	2.6	0.08
Amaranthus caudatus	Spinach	0.8	12.3	0.24
Amaranthus hybridus	Bush green	1.9	7.4	0.22

Source: [71].
a. Contents are given as weights per 100 g of fresh weight.

TABLE 2. Potential contribution of green leafy vegetables to daily requirements of vitamin A

	In vitro accessible all-trans-β-carotene per portion (μg)		Contribution to daily vitamin A requirement (%)	
Green leaves	Without oil	With oil	Without oil	With oil
Amaranth (*Amaranthus* sp.)	360	701	45	88
Cow pea (*Vigna unguiculata*)	419	1792	52	224
Sweet potato (*Ipomoea batatas*)	166	867	21	108
Pumpkin (*Curcubita* sp.)	429	1607	54	201

Adapted from: Mulokozi et al. [72].

TABLE 3. Mineral content of some indigenous African sauce condiments

	Copper	Iron	Zinc	Calcium	Magnesium
Condiment	mg/100g dry product				
Badkudi	1.01	4.21	2.06	485.38	314.84
Sili (*Sesamum alatum*)	1.63	3.67	5.18	875.58	248.33
Zabne	0.81	3.90	5.16	267.32	178.56
Kapok (*Ceiba guineensis*)	0.84	6.41	1.77	1028.15	588.85
Egusi (*Cucumeropsis edulis*)	1.77	5.51	4.11	87.68	390.7

Source: [76].

cerns arise about the definition of the best assessment tools for evaluating diversity in diets and nutritional outcomes. Two commonly used measures of dietary diversity are the food variety score, which estimates the number of food items consumed during a recording period, and the dietary diversity score, which estimates the number of food groups consumed. Both methods have measurement issues related to their use and interpretation in developing countries.

With regard to the food variety score, Kennedy [82] asked what constitutes variety and noted that variety in certain selected foods, such as energy-dense foods, may actually contribute to obesity. The definition of "variety" is relevant in sub-Saharan Africa and some other parts of the developing world where carbohydrate staples in the form of tubers and cereals form the bulk of dietary constituents. Can a meal of mixed carbohydrates, such as fried yams, sweet potatoes, and plantains, be described as diverse? Hatloy and colleagues [83], however, reported that both the food variety score and the dietary diversity score adequately validated dietary diversity and nutrient adequacy, although in their comparison of the measures by regression analysis, they reported that the dietary diversity score was a stronger

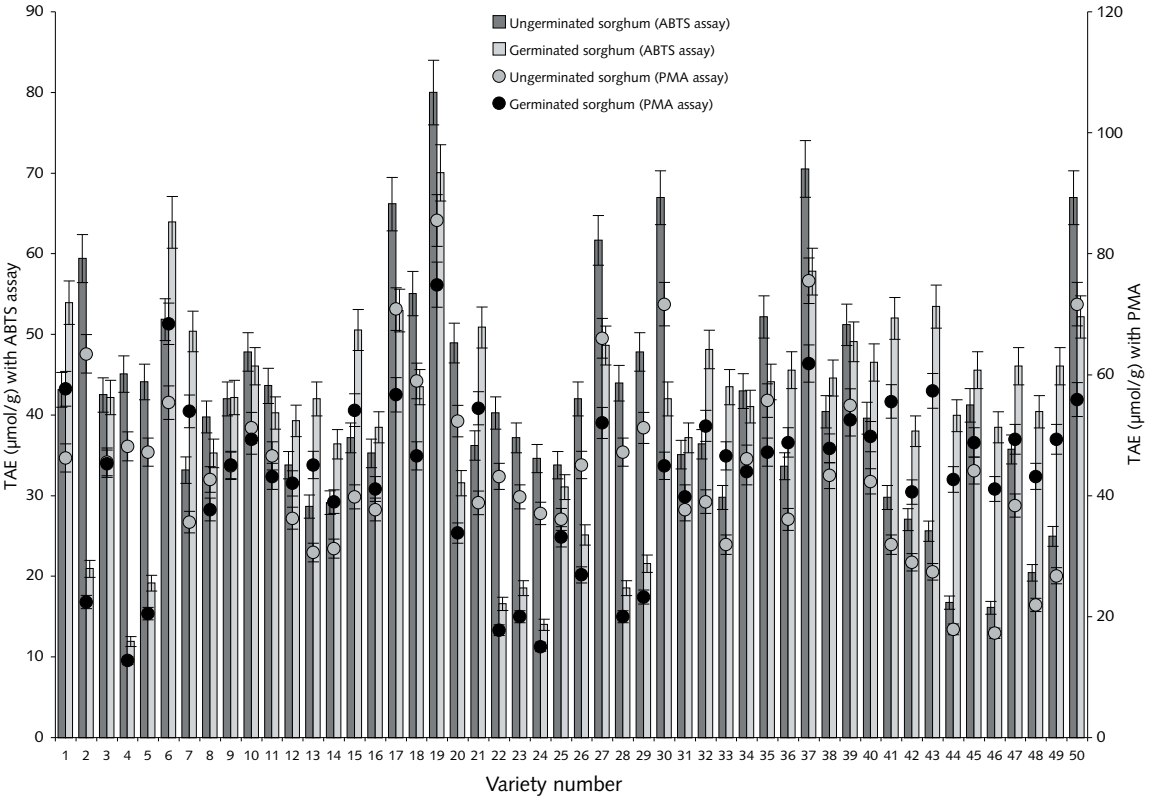

FIG. 1. Phenolic compounds and antioxidant activities in sorghum varieties
ABTS, 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid); PMA, phosphomolybdenum assay; TAE, trolox antioxidant equivalents.
Source: Dicko MH, Gruppen H, Traore AS, van Berkel WJH, Voragen AGJ. Evaluation of the effect of germination on phenolic compounds and antioxidant activities in sorghum varieties. J Agric Food Chem 2005;53:2581–8. Reprinted with permission [74].

indicator of nutrient adequacy than the food variety score. Two other groups of researchers [55, 84] have also found the food variety score to be a sufficiently adequate measure of dietary diversity. In a recent study in Dakar, Senegal, Spigelski [85] showed that the food variety score derived from a simple seven-day food frequency questionnaire was a valid indicator and was superior to the dietary diversity score. Nevertheless Krebs-Smith and colleagues [86] believe that dietary diversity is best assessed by measuring intakes of foods from different major groups. However, deciding which food category falls into which group is a problem with the use of the dietary diversity score, and several groupings have been suggested [86, 87]

According to Kant [87], categorization of foods into groups would require publicly available databases in which the constituents of mixed foods were disaggregated. In sub-Saharan Africa, and probably in some other developing countries where many dietary constituents are not reflected in contemporary food-composition tables, there would be a need to determine which foods or groups of foods fall into which food category. The unavailability of food tables and databases in sub-Saharan Africa places serious constraints on the effectiveness of the dietary diversity score.

A study in Mali by Torheim and colleagues [88] underscores the effect of cultural dietary patterns on these measurement indices. Sauce condiments and spices are used in food preparation all over West Africa, but in the Mali study spices and sauce condiments were not included in the score. It could be argued that these items are used sparingly in food preparation. But how small is "sparingly," and what if the spices or condiments are used two or three times a day? Condiments are believed to contribute diversity and nutrients to daily diets (**table 3**). How then can variations in the way condiments are used in sub-Saharan Africa be reflected in the measure of dietary diversity? In a study on food variety and diversity scores as a measure of diet quality and nutritional outcomes in Burkina Faso, Savy and colleagues [89] classified condiments and spices as a separate group and found that the rate of their daily use was 100%. These researchers observed a clear and positive link between overall dietary quality and the nutritional status of the subjects in the study, and they confirmed that the dietary diversity score was a better index of diet quality. According to these researchers, the dietary diversity score provided more information to describe the type of diet and the nutritional quality, and the dietary diversity score was more significantly

linked with anthropometric indices than was the food variety score. In a review of the subject, Ruel [90] suggested that many issues still need to be addressed to better identify changes or variations in dietary patterns of populations over time. Nonetheless, for sub-Saharan Africa in particular and for other developing countries, the consensus favors the use of the dietary diversity score to assess dietary diversity and nutritional outcomes, the need for more research to clarify the issues of food groups notwithstanding. However, the need may exist to have regionally different food groups that would make comparisons of regional studies and results easier to interpret.

Also unresolved are the nature of the ideal intake assessment tool, the best reference period for the study of food intake (1-day, 3-day, or 7-day food frequency questionnaire versus 24-hour recall), and the importance of the quantity and frequency of food items consumed. The 24-hour recall method is commonly used for its ease and rapidity, but it fails to capture daily variation in dietary intakes, particularly in urban communities. A repeated 24-hour recall performed on the same subjects might provide information on dietary variability, whereas 24-hour recalls performed during the lean period and also during the season of plenty would provide far more valuable information on the seasonality of food intakes, particularly among rural populations. Spigelski [85] observed that a single 7-day food frequency questionnaire provided indicators of nutrient adequacy comparable to those provided by the food variety score and the dietary diversity score derived from three nonconsecutive 24-hour recalls conducted over a single season.

The study by Savy and colleagues [89] highlighted an interesting dietary pattern of the rural communities studied, where food preparation techniques were basically the same in the study population and included cereals (98.6% of meals), leafy vegetables (87.1% of meals), and condiments (100% of meals). The dietary diversity model developed and used in this study appears relevant for the subcontinent, and with modifications addressing the issues highlighted it holds considerable promise for studies on dietary diversity in sub-Saharan Africa.

Initiatives of the International Plant Genetic Resources Institute

IPGRI has set itself the strategic goal of deploying agricultural biodiversity to improve nutrition and livelihoods in rural and poor communities in developing countries. Its nascent program on dietary diversification focuses on revitalizing indigenous food systems and promoting the increased utilization of biodiversity for improved nutrition. IPGRI is well aware of the limited evidence base linking biodiversity, nutrition, and health in several developing countries. Starting with sub-Saharan Africa, it has therefore embarked on the development of research partnerships for the analysis of the nutrient and non-nutrient properties of indigenous and traditional foods and the compilation of an easily accessible database on the diversity of nutrients and bioactive compounds in traditional foods within and between food crop species, while at the same time continuing the dialogue with policy makers in the agriculture, health, and rural development sectors on the benefits of using agricultural biodiversity.

IPGRI is involved in two major projects to promote dietary diversity within traditional food systems. The ongoing International Development Research Centre (IDRC)-supported project aims to advance dietary diversification in Kenya, Senegal, Uganda, and Tanzania as a long-term sustainable strategy to address nutritional deficiencies and health problems associated with the emergence of simplified diets. Within these country projects, IPGRI has forged partnerships with international agricultural research centers, national agricultural research systems, universities, national and local government agencies, and community-based organizations in an effort to build and maintain the momentum and capacity to stem and reverse the erosion of agricultural and dietary diversity.

The second project on African leafy vegetables, in which IPGRI has had demonstrable success [91, 92], targets the production and use of biodiversity. It focuses on increasing knowledge of the diversity of locally available leafy vegetables among communities in participating countries while making the vegetables available in forms that can be readily used by the communities. The program involves the documentation of indigenous knowledge and genetic diversity, as well as nutritional analysis, in order to establish a clear link between agricultural biodiversity and nutritional well-being. Detailed information on this program is available in the report by Oniang'o and colleagues [91]. The first phase of the program, involving scientists and development organizations from Botswana, Cameroon, Kenya, Senegal, and Zambia, provided baseline information on the species in common use, their genetic diversity, indigenous knowledge of the various uses of leafy vegetables, the significance of traditional vegetables in community diets, local vegetable production systems, and nutritional data on some of the identified cultivars. The results of this phase of the five-country project have been published [92].

The second phase of the program focuses on enhancing the role of African leafy vegetables in improving food security, nutritional status, and livelihoods through improved processing and preparation methods, promotion of increased consumption through recipe development, improvement of indigenous varieties, and management of genetic diversity. Activities of this phase in Kenya in particular have included

agronomic, nutritional, and taxonomic research on available cultivars, improved seed systems, improved handling and processing, and improved marketing systems for African leafy vegetables. In Kenya, the project has had a significant impact in raising the profile of African leafy vegetables, whose production is now a profitable venture, with women taking up the trade in addition to being major consumers. The Kenyan country project has significantly improved the livelihoods of farmers in the project areas by providing them with high-quality seeds and market opportunities in the informal and formal sectors. The appearance of African leafy vegetables in supermarkets in Nairobi has elevated their status among middle- and high-income consumers. Although no measurements were undertaken to ascertain the nutritional outcome of this program, it has succeeded in reintroducing indigenous leafy vegetables into the diets of consumers in Nairobi while at the same time increasing incomes for producer families. The program is, however, still ongoing, with a food-consumption survey currently documenting the consumption of traditional foods in the urban and periurban areas of Nairobi.

A strategy for agricultural biodiversity and nutrition

IPGRI and its partners are working to implement scale-up efforts in various regions around the world, encouraged by the gains already realized in small-scale and local pilot efforts. Making this approach work will require several different kinds of undertaking, including an evidence-based approach to nutrition and health and sustainable agriculture by small-scale farmers; the evaluation and use of local foods, food variety, and traditional cuisines; culturally sensitive methods; nutrition education; research on novel and improved methods of food storage and processing; and enhanced attention to marketing. The outcomes, too, are manifold and generally mutually reinforcing. They include better health, conservation of agricultural and wild biodiversity, reduced poverty and enhanced incomes, public education, and sound public policy.

In the conceptual representation in **figure 2**, biodiversity, markets, and culture are all essential components of intact food systems that support the health and nutrition of populations, and they are in turn enhanced by a positive impact of biodiversity on nutrition. As noted by Johns and Sthapit [93], "The model assumes that small-scale farmers can manage and use traditional agro- and wild biodiversity to comparative economic advantage on the premise that the products marketed are desired by, and offer nutritional and sociocultural benefits to (increasingly urban) consumers. Linking biodiversity and health is both a response to the consequences of economic growth and a way to direct growth in a positive manner."

Realization of the potential of agricultural diversity as part of healthy food systems will also depend on

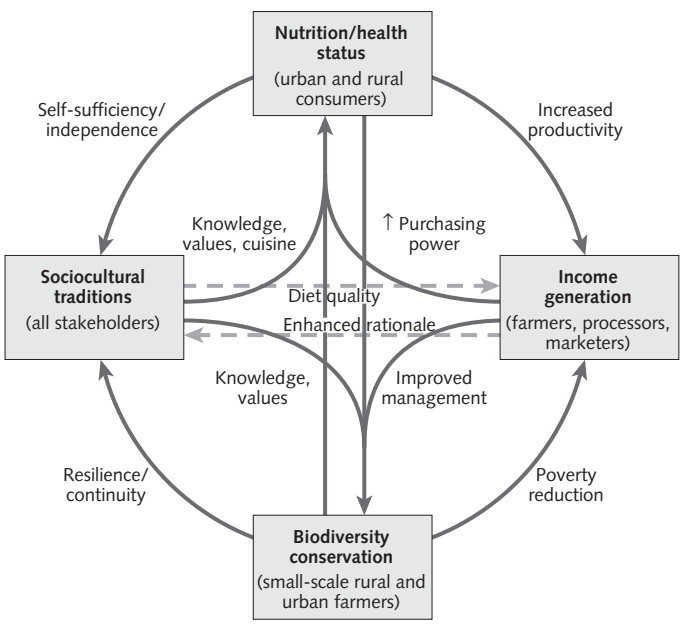

FIG. 2. Population–level synergies linking agricultural biodiversity and human nutrition in developing countries. Positive feedback loops ensure that benefits are widely enjoyed and offer several entry points for a durable strategy to use agricultural biodiversity to improve livelihoods Source: [93].

strengthening international and national policies. The need to integrate nutrition considerations beyond those of food security into agriculture, livestock, aquaculture, and related programs has been recognized by others [94]. The basis of the integration is that the food systems of target communities make use of a wide range of plant and animal resources as food. While research is compartmentalized, in the household food culture and consumption patterns these food resources are combined and interdependent. Thus issues of dietary diversity and related nutrition indicators must be integrated into a broader framework for suitable guidance of agricultural and poverty-reduction strategies targeted at providing access to adequate dietary variety to the vulnerable groups among both the urban and the rural poor. The Chennai Platform for Action for a Hunger and Poverty Free World [95], adopted following an international consultation held in April 2005, of which IPGRI was a co-organizer, outlines a way forward. Similarly, IPGRI and the FAO in consultation with other interested organizations are collaborating with the Secretariat of the Convention on Biological Diversity in a Cross-cutting Initiative on Biodiversity for Food and Nutrition, as requested in Decision VII/32 of the Conference of the Parties (COP7) of the Convention.

In order to meet the objective of identifying and making use of available nutrient-rich indigenous and traditional food crops to help the world's poor and malnourished to diversify and thus improve their diet, there is a clear need for collaboration and coordination among the immensely varied scientific disciplines involved. The Alliance of Future Harvest Centres of the Consultative Group on International Agricultural Research (CGIAR) is well placed to contribute to the research that further sustainable development will need. The Alliance includes centers devoted to specific crops, for example, rice, wheat and potatoes. It also includes centers devoted to particular ecosystems, such as arid lands and forests, and centers devoted to more general issues, such as water, food policy, and, indeed, agricultural biodiversity. Working together with one another and with partners from national programs, international organizations, and the private sector, the centers can help communities and development agencies use agricultural biodiversity to meet the food security, nutrition, and health needs of poor communities in developing countries.

Conclusions

The approach to nutrition and biodiversity described here may seem complex, and in a world increasingly devoted to simple, technological fixes, that could be seen as a drawback. But although diversity is inherently complex, the interventions foreseen are essentially simple, though not simplistic.

The successes to date of IPGRI's nascent program on dietary diversification is evidence that agricultural biodiversity can be effectively mobilized as a primary resource for food security and health. However, to build and maintain the momentum and capacity to stem and reverse the erosion of agricultural and dietary diversity, there is need for investments in the revitalization and mobilization of indigenous and traditional food systems, the reintroduction of indigenous and traditional foods into dietary habits, and the provision of a strong evidence base linking agricultural biodiversity to nutrition, health, and improved well-being of developing country populations.

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SPECIAL REPORT

Child Nutrition Initiative in Israel and Palestine: Status of food security, micronutrient malnutrition, and behavioral change and communication programs

Compiled and summarized by Aron M. Troen, Drora Fraser, Ziad Abdeen, and Irwin H. Rosenberg

Introduction

From February 7 to 9, 2005, a conference cosponsored by three universities with a strong history of interest in child nutrition and food security was held in Beersheba, Israel. The sponsors were the Al Quds Nutrition and Health Research Institute at Al Quds University, the S. Daniel Abraham International Center for Health and Nutrition at Ben Gurion University, and the Friedman School of Nutrition Science and Policy at Tufts University.

The rationale for the conference and for initiatives that would follow was the perceived need to apply the best scientific techniques for the analysis of the problems in child nutrition and food insecurity in both Israel and the West Bank and Gaza, since reports of worsening conditions had been appearing over the past four years. A planning meeting for a conference that would accurately describe the current situation with regard to child nutrition in the region and consider priorities for intervention and ongoing study was held at Ben Gurion University in May 2004. Specific planning for the February 2005 conference was assigned to three working groups, each with participants from all three universities. Each university took the lead for one group: Ben Gurion University headed the food security working group, Tufts the working group on micronutrient nutrition, and Al Quds the working group on behavioral change and communication.

Prior studies in the area in the previous literature were surveyed extensively and placed on a website "Child Nutrition in Israel and Palestine: Seeking Joint Initiatives" (http://nutrition.tufts.edu/conferences/childhood). Fifty scholars, scientists, and national and international ministry officials gathered in February 2005 to review the data describing the nutrition and food-security status of Palestinian and Israeli children, with the additional goal of identifying gaps in knowledge and opportunities for program initiatives that would, when possible, be carried out jointly or in coordination in both populations.

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Food security in Israel and Palestine

Israel

In 2003, a study to assess the extent of food security was carried out by the Brookdale Institute (Smokler Center) in partnership with the Ministry of Health, the National Insurance Institute, the Ministry of Social Affairs, and the Forum to Address Food Insecurity and Poverty in Israel [1]. The study found that a significant portion of the population (22%, 1.4 million) was food insecure, and 8% (514,000) was food insecure with hunger. These population groups reported problems of access to adequate and appropriate food attributable to economic difficulties. In addition, the Report on the dimensions of poverty and wage disparities which was issued by the National Insurance Institute of Israel for the years 2004/2005 [2] indicated that 34.1% of Israeli children are below the poverty line, a 50% increase since 1998, underlining the urgency of efforts to eradicate food insecurity among children.

National school feeding programs have been discussed as one means of alleviating food insecurity among children, with the added benefit that this serves as a platform for nutritional education. A pilot school lunch program, funded jointly by the nonprofit sector (the Rashi-Saatchi Foundation) and by the National Insurance Institute of Israel, was initiated in 2004 aimed at 22,500 school children. Lunches will be provided through schools in poor rural and urban communities representing all sectors of Israeli society (Beit Sh'an, Tirat Hacarmel, Ramat Gan, Beersheba, Ofakim, Iblin, Ar'ara, and Beitar Ilit)and through extracurricular frameworks in 25 other communities [3]. If successful, the pilot study might be scaled up to include 500 schools, reaching 154,000 children. In

addition, there are 120 elementary and day boarding schools nationwide that provide cooked lunches. In spite of the promise shown by the school feeding program, it cannot reach a majority of all the food-insecure,and its extension beyond the pilot stage is uncertain Moreover, a host of issues, such as eligibility, equity, food nutritional quality, and food safety, will need to be resolved before wide-scale implementation of school programs will be able to alleviate food insecurity among children.

Palestine

With rising poverty and unemployment, the food-security situation has worsened in the PA since the year 2000. The Al-Quds Nutrition and Health Research Institute baseline study conducted in 2003 found that approximately 55% of Palestinians were food insecure, with 30% more at risk for food insecurity given the current conditions. [4]. Similar findings were also reported by the FAO study [5]. Access to food and farmers' access to the inputs to produce food also contributed to food insecurity. Losses of jobs, earnings, assets, and incomes have sharply reduced economic access to food, with real per capita income decreasing by half since 1999, resulting in 6 out of 10 people falling below the poverty line of US$2.10 per day. Currently, insufficient coping strategies and the inability of the social safety net to adequately protect the vulnerable population have resulted in reductions in the quantity and quality of food consumed. These are all factors that place the Palestinian population at risk for increasing food insecurity. A follow-up food-security assessment carried out by the WFP in June 2004 found that 37% of the Palestinian population, some 1.3 million people, are food-insecure and another 27% (975,000) are at risk. These figures represent a slight improvement from 2003, when 40% of the population was estimated as food-insecure, and 31% as vulnerable.

In summary, recent years have seen a trend of rising food insecurity in both populations. These trends are reversible. However, there is not enough information on the effectiveness of the existing national-level social safety nets in combating food insecurity. There is a need for research on food safety nets, their scale of operations, and their effectiveness in both populations. Given the volatility of those conditions that lead to food insecurity, food security should be monitored regularly.

Micronutrient status: "The silent hunger"[1]

There is evidence of micronutrient deficiencies from national dietary intake surveys in both Israel and Palestine. Recent published articles with nutritional biomarkers support this finding. However, there is a paucity of supporting biochemical evidence at the national level, especially among infants, children, and women of childbearing age.

Iron deficiency is a public health problem in both populations [6]. Israel and Palestinian's 1999–2000 National Health and Nutrition Survey showed inadequate intake of iron. Recent literature demonstrates iron deficiency among all age groups, especially children, in both the Jewish and the Bedouin populations as well as in the West Bank and Gaza. In the West Bank and Gaza, issues of availability and accessibility of iron supplementation need to be addressed, as well as other strategies to increase iron status.

Iodine deficiency in the region was documented as early as 1959. Neither Israel nor Palestine has a universal salt iodization program, nor do they have iodine control programs. More recent published studies from Israeli coastal areas and among schoolchildren in the West Bank and Gaza show the presence of iodine deficiency in both Israel and Palestine. There is an urgent need for corrective measures to safeguard the populations, especially pregnant women, infants, and young children, from the deleterious effects of iodine deficiency.

In 2003, a vitamin A assessment was performed by the Palestinian Ministry of Health with USAID in the West Bank and Gaza strip. The MARAM project performed a vitamin A assessment in children aged 12 to 60 months and found an overall prevalence of vitamin A deficiency of 21.8%, with a prevalence of 26.6% in the Gaza Strip and 18.6% in the West Bank. Although no survey data are available, published papers also suggest the presence of vitamin A deficiency in the infant and child population in Israel. The most recent research suggests the presence of vitamin A deficiency throughout the region; however, additional data are needed at the national level regarding vitamin A status.

In the West Bank and Gaza, as well as in Israel, there is evidence of inadequate folate intake. The 2003 MARAM Project showed that in the West Bank and Gaza, more than half of children from 1 to 3 years old and more than three-quarters of children 4 and 5 years old were deficient in daily folate intake. The 1999–2000 National Health and Nutrition Survey in Israel reported that folic acid intake was inadequate and noted a need to increase folate consumption among women of childbearing age. Folate deficiency has also been found in some elderly Israeli populations, suggesting low dietary intake of folate throughout the population [7].

The 1999 –2000 National Health and Nutrition Survey in both Israel and Palestine also revealed that vitamin B_{12} intake is markedly below daily recommendations among adult males. Overall, there is a lack of research concerning vitamin B_{12} and children in Israel

Complete references are available at http://nutrition/tufts.edu/conferences/childhood.

and the West Bank and Gaza. However, evidence of low vitamin B_{12} levels among adult populations in both Jewish and Arab populations throughout the region suggests low vitamin B_{12} intake in all age groups.

Vitamin D deficiency has been documented in Israel, and data are not yet available regarding vitamin D status in Palestine. Low dietary zinc intake was documented in nutritional assessments of the West Bank and Gaza Strip in 2002 and 2003. Data regarding zinc status in Israel are not available; further investigation is required.

Working group recommendations

After discussion of the presentations on the nutritional status of the populations, it was decided that the working group sessions would be conducted in two rather than three groups, with the food-security and the behavioral change and communication groups consolidated into one.

Food security and community mobilization for peace and stability: Working group recommendations

The behavioral change and communication group and the food-security group met together under the rubric of "Food Security and Community Mobilization for Peace and Stability." This group emphasized regional and binational assessment, the importance of assessing local populations, and the need for training. Several pilot programs were proposed, with special attention to school breakfast and lunch programs as an approach to food insecurity.

The participants agreed that secure access to culturally acceptable, safe, and nutritious food is an essential foundation for both peace and desired behavior change, and that peace is a prerequisite for true food security. Food security must feed the peace, and peace will nurture food security.

The group identified a number of pressing concerns, including but not limited to food safety, food accessibility, social and economic barriers to food security, fundamental food availability, and nutritional status of various vulnerable populations. The participants also discussed various activities, including assessment research, pilot interventions, and evaluation research and monitoring. These activities ranged in scope from the binational and regional levels to levels as local as that of an individual school canteen. The list of ideas generated by the group generated considerable enthusiasm and should serve as a general agenda for studies and action research.

Regional or binational assessment

The participants felt strongly that food-security monitoring should be institutionalized on a regular basis in both Israel and Palestine. The household food-security module developed by scholars in the United States in cooperation with the US Department of Agriculture has proved adaptable to a variety of national settings and has been used in the region. This tool, which costs relatively little to administer and is built upon sound and tested measurement science, can provide the basis for regular surveys in both populations to identify populations at risk and highlight changes in the state of food security nationwide. The groups felt that the data collection should be conducted at a national level but that the Universities might contribute to the evaluation of such data.

Assessment of local and special populations

Assessment and monitoring activities on a narrower scale were also proposed. Specifically, the participants proposed assessment of food in school canteens, as well as assessment of food security in special populations likely to be underrepresented in national surveys due to lack of telephones, such as Bedouins living in unrecognized towns. Similarly, assessment of the coping strategies used by food-insecure and vulnerable groups was suggested, preparatory to undertaking projects involving the positive deviance approach to behavior change. These and a host of possible similar projects appear to be appropriate routes for involving graduate students, as well as means of filling gaps in knowledge and generating impetus for change. Training in monitoring and assessment of food security would be a likely component of preparation for such projects. The creation of a data bank for food-security studies and/or the use of an existing data-sharing file in Palestine was also proposed.

Training

In order to generate greater awareness of food insecurity, the group proposed specialized education and training for social services, health, and education practitioners, including those involved in preschool education and child care. Such an initiative could be carried out at the local, national, and/or regional levels. Training would also be an important component of the proposed effort to increase the capacity of laboratory testing for food safety and food contamination. Expansion of laboratory facilities and technology transfer was suggested as a means for building capacity and interuniversity collaboration.

Interventions

Several small-scale, targeted pilot programs were proposed. Support for home gardens (with attention to water collection and use as well as wastewater treatment) was suggested. The participants recommended educational outreach, designed to include both men and women, focusing on management of the food and nutrition transition, nutrition for children under two,

or both. Peer support programs (woman-to-woman, child-to-child) were suggested as a preferred modality. The group saw as particularly promising a pilot school breakfast program in which children or adolescents would be involved in the planning of menus and the preparation and serving of food, and nutrition education would be integrated in the curriculum. The participants felt that this type of intervention might have the potential to influence the policy debate at the national scale in either or both nations. The proposed pilot interventions would need to be rigorously evaluated, suggesting a need for expanded training in evaluation and a possible role for universities as consultants or technical assistance providers to nongovernmental organizations.

The proposed school lunch programs would incorporate the following principles:

- Equity of nutrition for pupils throughout the country;
- Provision of high-quality nutritional foods;
- Positive nutritional environment (no vending machines on school premises, healthy food options in cafeterias);
- Donation of surplus food to lower-income groups in the community;
- Emphasis on recycling;
- Student involvement in meal preparation and analysis of the nutritional value of foods;
- Addition of nutritional and behavioral education to the school syllabus, with involvement of nutritionists in teaching and building these programs;
- Involvement of parents and their commitment to choosing healthy food at home;
- Positive environment in the school cafeteria, with supervising teachers providing a positive role model with respect to nutritional behaviors;
- Provision of adequate free drinking water from suitable water fountains;
- Annual monitoring for quality and nutritional value of food, children's knowledge and attitudes, and children's height and weight.

The participants agreed that a national policy of universal free school meals should be implemented beyond the pilot program level, and strategies for moving toward this goal were discussed. National-level policy was also the target in proposals for integrating nutritional assistance, nutrition education, and postnatal health care.

For interventions and research activities, the participants felt that an active and sustained exchange of ideas, information, models, and materials should be undertaken, which would be facilitated by exchange visits of faculty and students.

In each of the action areas discussed above, work was envisioned as proceeding from situation assessment through design, implementation, and evaluation of the intervention, to a scaling-up process leading finally to a policy proposal. Thus, for example, an assessment of what children are actually eating in the school canteens in Palestine would be followed by design of an intervention such as an integrated school meal and behavioral change program. If this program were successful, it could lead to the design of national legislation and advocacy for its passage.

The agenda of worthy and urgently needed training, assessment, intervention, evaluation, and policy measures clearly exceeded the group's resources of time, energy, and funds. In order to enlist a broader range of actors and create access for policy makers, a conference on food security in Palestine and Israel was proposed.

Micronutrients: working group recommendations

The micronutrient literature review prepared as background for the meeting is comprehensive and points to prevalent micronutrient deficiencies in the Israeli and Palestinian population. Gaps in this information need to be filled, but there is sufficient basis for use of the review as an evidence base by the National Academies to advocate implementation of governmental nutrition policies as well as for community mobilization.

Special attention was given to flour fortification with B-vitamins, iron and possibly other micronutrients as a priority area for action. In Palestine, plans for flour fortification are in advanced stages, with initial implementation scheduled for September 2005. The policy process in Israel is also in the advanced stages, but implementation is lagging and needs to be advocated strongly. Monitoring of fortification will be a priority, and integrated complementary programs need to be developed.

Based on these observations, the academic representatives of the three universities agreed to urge the implementation of supplementation and fortification programs with adequate scientific oversight and monitoring, in order to alleviate micronutrient deficiencies in Israel and the West Bank and Gaza. The Micronutrient Group reviewed evidence in the literature for prevalent micronutrient deficiencies in the Israeli and Palestinian populations and publicized the results on the conference website (http://nutrition.tufts.edu/conferences/childhood). The group discussed approaches to their remediation and priorities for intervention, with special attention given to fortification. The group strongly urges progress to be made on the implementation of food fortification, with provision for monitoring the implementation and health impact of such programs.

The three universities agreed to review the detailed fortification plans scheduled for implementation in Palestine in 2005 and proposed for legislation in Israel. The participants emphasized that particular attention should be given to the specificity of the elements of fortification, as well as monitoring and evaluation of

the impact of the proposed programs, including the extent of their mutual impact across both populations. Tufts University already has considerable experience with the Israeli fortification program, including formulation of fortified flour, quality control of the bread fortification, and human pilot studies to determine the impact of consumption of fortified bread. The Iron Deficiency Project Advisory Service (IDPAS) program at the Friedman School of Nutrition Science and Policy at Tufts University is another important resource for program evaluation, as well as for training and capacity building in this area.

In addition to food fortification that serves the population as a whole, the group recommended that home micronutrient fortification (sprinkles) should be tested for the prevention of anemia and other micronutrient deficiencies in vulnerable and high-risk groups, such as infants, schoolchildren, women of childbearing age, and the elderly. The participants agreed that any supplementation program should go hand in hand with an evaluation program. Efficacy, effectiveness, and safety testing should always accompany introduction of supplementation, whether as trials or as national programs.

Joint initiatives

The workshop participants agreed that the following joint initiatives should be pursued:

- A Three-University Micronutrient Nutrition Scientific Task Force should be formed as a nucleus for regional cooperation on these and additional topics.
- Monitoring and evaluation of all stages of the fortification programs should be a priority for cooperative programs, including:
  - Monitoring of population health status;
  - Process evaluation and quality control of fortified food;
  - Monitoring of distribution and use of fortified food;
  - Evaluation of the impact of fortification on both populations;
  - Acquisition of baseline and follow-up data.
- Training and student exchanges should be instituted between universities. The areas of laboratory assessment of micronutrients and methodologies for study design and evaluation are priority areas for building capacity.
- Feasibility and pilot studies of new interventions, such as supplementation with sprinkles, should be jointly developed for both populations, with design of similar protocols, outcome measures, and a joint core laboratory.
- Agreed definitions of micronutrient deficiency indicators and outcome measures should be established, since they would be useful for regional projects. Further research is also needed on micronutrient deficiencies that are not covered by published data and on environmental factors that influence nutritional status and health outcomes.

A look to the future

The steering committee representing the three universities recognized the magnitude of the problem of food insecurity and undernutrition in both Israeli and Palestinian populations and emphasized the need for evidence-based interventions, with careful monitoring and evaluation. The members also noted the pressing need for a comprehensive and ongoing system of data collection and program evaluation in nutritional food security. The combined scientific capacities of the three universities are well suited to provide analytical skills, program design and evaluation capacity, and methodological insights. The ongoing activities of the combined working groups in micronutrient nutrition and in food security and community mobilization will provide opportunities for capacity building and will require additional fundraising.

An important next step in the further evaluation and implementation of programs was taken at a meeting sponsored by the National Science Academies of Israel, Palestine, Jordan, Egypt, and the United States in Jerusalem in May 2005, at which time a detailed proposal for micronutrient fortification plans for flour was described. The intention of the three universities was to move forward with the evaluation of nutrient fortification programs in Israel and Palestine as one important approach to problems of child and population malnutrition, with specific proposals for baseline evaluations and monitoring of interventions. The three universities proposed a first joint program by invitation of USAID, entitled: "The Estimation of Dietary and Nutrient Adequacy of Palestinian Communities Residing in the West Bank and Gaza in Support of the Introduction of Wheat Flour Fortification." Unfortunately, the project was not approved as the joint Israeli-Palestinian and American effort envisioned by the participants of this conference, and it is being carried out independently by Palestinian and other parties.

Acknowledgments

For their vital contributions to the planning and organization of the conference and the writing of this report, the authors would like to acknowledge the co-chairs of the Food Security working group, Mohammed Shaheen (Al Quds) and Roni Kaufman (BGU); the co-chairs of the Behavioral Change and Communications working group, Kathline Abu-Saad

(BGU) Haleama Al Sabbah (Al Quds); and research associates Denish Moorthy and Patrick Racsa (Tufts). The conference was sponsored through an educational grant by the Ridgefield Foundation, created by Henry J. and Edna D. Leir, with additional support from the S. Daniel Abraham International Center for Health and Nutrition and the Kreitman Foundation at Ben Gurion University of the Negev.

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Letter to the Editor

Anthelmintic treatment improves the hemoglobin and serum ferritin concentrations of Tanzanian schoolchildren

To the Editor:

It has been called to our attention that there were calculation errors in **table 1** of our paper [1; p. 336]. The values for the sample means of the C-reactive protein levels (CRP) were inadvertently multiplied by 10. The correct sample means of the CRP levels for the control and treatment groups in **table 1** should read as follows:

TABLE 1. Selected variables in three survey rounds of Tanzanian schoolchildren in the treatment and control groups (means ± SD)

	Control group ($N = 602$)			Treatment group ($N = 331$)		
Variable	Round 1	Round 2	Round 3	Round 1	Round 2	Round 3
C-reactive protein (mg/L)	2.39 ± 3.82	2.09 ± 3.50	2.06 ± 3.07	2.10 ± 2.97	2.09 ± 3.31	2.07 ± 3.38

The authors thank Dr. D. Thurnham for pointing out our errors.

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Reference

1. Bhargava A, Jukes M, Lambo J, Kihamia CM, Lori W, Nokes C, Drake L, Bundy D. Anthelmintic treatment improves the hemoglobin and serum ferritin concentrations of Tanzanian schoolchildren. Food Nutr Bull 2003;24:332–42.

Book reviews

Nevin S. Scrimshaw

Chemistry and safety of acrylamide in food (Advances in Experimental Medicine and Biology). Edited by Mendel Friedman and Don Mottram. Springer, Secaucus, N.J., USA, 2005. (ISBN 0-387-23920-0) 466 pages, hardcover. US$169.00.

In 2002, reports that acrylamide formed during the processing of plant-derived foods was found in the foods at levels of up to 3 mg/kg resulted in heightened worldwide interest in the safety of acrylamide in human diets. This book is based on the presentations of 36 speakers at a three-day symposium held on the issue in March 2004. It discusses a very wide variety of related topics, including mechanisms of formation of acrylamide in food, distribution in food, toxicology, pharmacology, metabolism, epidemiology, and risk assessment.

The book covers well what was known about acrylamide in food in 2004 but lacks discussion of its biological and human health significance. Under "toxicity" in the index, there is reference to only one chapter. Genotoxicity and DNA damage in lymphocytes are described, but they occur only at levels of acrylamide at least 10 times higher than those found in foods.

Clinical nutrition (The Nutrition Society Textbook). Edited by Michael J. Gibney, Elia Marinos, Olle Ljungqvist, and Julie Dowsett. Blackwell Science, Malden, Mass., USA, 2005. (ISBN 0-632-05626-6) 480 pages, softcover. US$59.99.

This clinical nutrition textbook developed by the Nutrition Society of the United Kingdom focuses entirely on the nutritional management of the sick and metabolically compromised patient. It covers the scientific basis for nutritional support, evaluation of nutritional support, nutrition counseling, and medical ethics. It is designed to provide medical students with the required scientific background in clinical nutrition and does this well. The chapter topics are well selected and treated in appropriate depth.

After dealing with nutritional assessment, successive chapters cover overnutrition, undernutrition, metabolic disorders, eating disorders, adverse reactions to foods, nutritional support, ethics and nutrition, the gastrointestinal tract, nutrition in liver disease, nutrition and the pancreas, the kidney, nutritional and metabolic support in hematologic malignancies and hematopoietic stem cell transplantation, the lung, nutrition and immune and inflammatory systems, the heart and blood vessels, nutritional aspects of disease affecting the skeleton, nutrition in surgery and trauma, infectious diseases, nutritional support in patients with cancer, pediatric nutrition, cystic fibrosis, and water and electrolytes. A final chapter presents 10 case studies related to specific nutritional problems in disease.

This is a very good clinical nutrition textbook. It is complemented by similar texts on "Public Health Nutrition" and "Nutrition and Metabolism." The Nutrition Society has also produced a more elementary "Introduction to Human Nutrition."

Food and human rights in development. Volume 1: Legal and institutional dimensions and selected topics. Edited by Wenche Barth Eide and Uwe Kracht. Intersentia, Antwerp, Belgium, 2005. (ISBN 90-5095-385-9) 528 pages, softcover. US$58.00.

The right to food is firmly established in human rights law, and the editors and the 15 authors of this volume have made important contributions to this. Following the recommendations of the 1996 World Food Summit, much effort has gone into the conceptualization of cultural and social rights in general and specifically of the right to adequate food. The United Nations, nongovernmental agencies, governments, scholars, and civil society have all been involved in providing a foundation for international and national efforts on behalf of the right to adequate food for all.

This first of two volumes summarizes some of the

results of this work and gives direction to future activities. In addition to reviewing the concept and history of the right to food and elaborating on its theoretical basis and meaning in the development process, it provides some informative recent practical examples of the human rights approach at the national and international level. The book illustrates how broader development concerns can be addressed through a nutrition-related human rights perspective that incorporates research in progress. The second volume will focus on implementation and will provide specific country and UN agency experiences.

The section on "Food in the Human Rights System" has chapters on economic and social rights in an age of globalization; democracy and the politics of hunger; from food security to the right to food; whose right to food: vulnerable groups and the hungry poor; and interrelationships between the right to food and other human rights. Five chapters deal with the legal and institutional dimensions of the right to food. A final five chapters deal with specific topics, such as the right to food of indigenous peoples, baby's rights and mother's duty to breastfeed, infant feeding and HIV/AIDS, the right to benefit from science, and the influence of traditional entitlement systems.

The past decade has been one of conventionalization, interdisciplinary and intersectorial exchange, and institutional lobbying, as well as of intense international and national promotion of the right to food as a fundamental human right. This volume argues this must now be followed by an increased effort to promote and document practical applications. It makes the case that human rights research should be equally relevant and useful to epidemiologic, interventional, and policy-related analysis pertaining to the human right to food and nutritional well being.

This book is the first of its kind on food as a human right and is intended to inform and stimulate discussion among scholars, policy makers, implementers, and activists about how to promote access to, and consumption of, safe, nutritionally adequate, and culturally acceptable food for all on a sustainable basis. The right to food is a test case of the extent to which the application of economic, social, and cultural rights can be an effective influence in a market-driven international climate.

The two books under the common title will enable professionals concerned with food and nutrition policy or its implementation to become familiar with the binding agreements and momentum toward recognizing and enforcing the right to food as a basic human right. For some, these volumes will stimulate research on the practical application of binding agreements on the right to food or encourage their active participation in the human rights movement.

Handbook of functional lipids (Functional foods and nutraceuticals). Edited by Casimir C. Akoh. CRC/Taylor & Francis, Boca Raton, Fla., USA, 2005. (ISBN 0-8493-2162-X) 544 pages, hardcover. US$159.95.

Functional lipids can be defined as those that provide specific health benefits when consumed or that provide specific functional characteristics when incorporated into a food. The rapid growth of the market for functional food has led to stepped-up efforts to develop functional lipids for the consumer market.

This handbook is the first comprehensive reference that describes the science and role of lipids in foods. It is divided into four parts: the isolation, production and concentration of functional lipids; how lipids confer desirable physical characteristics; how lipids are involved in human health and nutrition; and the role of biotechnology in creating functional lipids in response to commercial demand.

Nutritional and clinical management of chronic conditions and diseases. Edited by Felix Bronner. CRC/Taylor & Francis Group, Boca Raton, Fla., USA, 2005. (ISBN 0-8493-2765-2) 296 pages, hardcover. US$139.95.

It is finally being recognized by clinicians that nutritional status is a major determinant in virtually all chronic disease, and that the treatment and outcome of disease can often be markedly improved by dietary changes. Any book that authoritatively informs physicians about the application of modern nutrition to the management of disease can be useful, and this one meets that standard. However, for most of the topics, the chapters are too short to include the full range of information that a clinician would need in practice.

Although the chapters on adult weight control (35 pages), dermatology and nutrition (40 pages), food allergies (22 pages), and the specialized topic of surgery for the control of obesity (16 pages) are reasonably comprehensive, that on childhood obesity is not. The important topic of nutrition and immune function is dealt with only by an 8-page popular lecture. The 19-page chapter on genetic disease and errors of metabolism describes only a few common examples of the large number of such disorders. Other chapters are intermediate in coverage, and the selection of specialized topics is somewhat arbitrary.

For the most part, there is no problem with the quality of what is included; it is simply impossible to supply the information implied by the title in a volume of this type. It could, however, be a very useful supplementary text in a graduate or medical school course on clinical nutrition.

Soy in health and disease prevention. Edited by Michihiro Sugano. CRC/Taylor & Francis Group, Boca Raton, Fla., USA, 2005. (ISBN 0-8493-3595-7) 328 pages, hardcover. US$119.95.

It is increasingly recognized that soybeans are unique in the number of compounds that are beneficial to human health. They have been consumed in China for more than 4,000 years and were introduced into Japan and Korea in the sixth century A.D. Extensive and intensive research on the soybean's effect on nutrition and health took place for centuries in Asia before its introduction to the West, and much experience on the soybean's health benefits has been accumulated.

Japan is not only the country that is most advanced in the use of soybean for fermented foods; it has also had the most researchers studying all aspects of the effects of soy in human diets. However, much of this research is available only in Japanese. This book is unique in that it is edited by one of the most outstanding Japanese researchers in the field and 15 of the 17 chapters are written by a total of 24 experienced researchers from Japan. It encompasses all aspects of the evidence for the health effects of soybean.

The opening chapter identifies 16 components of soy with demonstrated health-related functions. These include hypocholesteremic, antiatherogenic, anticarcinogenic, antioxidant, antiallergic, and neurofunctional effects. All are reviewed in subsequent chapters, together with such topics as adipocytokines, the role of soy in lipid metabolism, longevity and age-related disease, and the bioactivity and functionality of soy peptides.

This book is a welcome addition to other articles and books on soybeans that are based primarily on research in the Western world.

News and notes

Special issue on human energy requirements: Scientific background papers of the Joint FAO/WHO/UNU Expert Consultation. *Public Health Nutrition*, Vol. 8, No. 7(A), October 2005

The recommendations of international experts on energy requirements throughout the life cycle are essential for assessing whether food supplies are adequate to meet a population's nutritional needs. It is the mandate of United Nations organizations such as the Food and Agriculture Organization (FAO) to provide a neutral and independent forum for scientists representing the wider interests of the global community to meet and deliberate on recommendations that are universally applicable to all nations, taking into consideration the specific problems that developing countries face. Hence, the development of pragmatic recommendations by expert committees convened by UN agencies that are based on objective scientific evidence and that have practical relevance to the conditions prevailing in the developing world is paramount.

The stated objective of expert consultations on human energy requirements convened by FAO, in partnership with other UN agencies, is to provide advice to the director-general and to member countries through their respective organizations on scientific issues related to foods and human nutrient requirements. The recommendations and guidelines that result from these consultations enable governments and organizations to better plan, monitor, and evaluate nutrition programs and policies. In turn, these programs and policies aid member nations in developing estimates of requirements appropriate for local conditions and for their relevant and direct applications in their own countries.

In July 2001, preceding the Expert Consultation on Human Energy Requirements held on October 17–21, 2001, working groups of experts were convened at FAO headquarters in Rome as part of a two-stage process to review new scientific knowledge that might influence the current recommendations for energy needs. The background papers that had been commissioned and peer reviewed were made available to both the preconsultation working groups and the experts who met for the actual consultation. Additional materials in the form of opinion pieces or reviews were also requested by the experts on specific topics. As was requested by the participants, and to ensure the objectivity and transparency of this process, a decision was made to ensure that all background documents were published in a peer-reviewed scientific journal. The added advantage was that the report of the Expert Consultation could be short and prescriptive, while the publication of the background documents would provide the scientific justification for the prescriptive recommendations contained in the report. These background documents are published in this supplement of *Public Health Nutrition*.

For more information regarding this special publication or to request a copy, contact the FAO at the following addresses:

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Nutrition Planning, Assessment and Evaluation Service
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
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New CD-ROM series: *FAO Food and Nutrition Background Documents*, December 2005

Since 1949, the Food and Agriculture Organization (FAO) has periodically convened groups of experts to evaluate current scientific knowledge in order to build consensus on defining human energy requirements and to propose dietary energy recommendations for populations. The World Health Organization (WHO) joined this initiative in the early 1960s and the United Nations University (UNU) in 1981.

The purpose of this new CD-ROM series entitled *FAO Food and Nutrition Background Documents* is to provide the scientific background papers and related documents generated from past expert consultations and meetings that serve as the basis for the international recommendations on human nutrient requirements. The scientific background papers that served as the basis of the two reports from the expert consultations on energy and protein requirements, held in 1971 and 1981, were never published. This is also the case for the background papers of other past consultations.

There are many reasons behind this initiative, including the fact that there are important changes taking place in the manner in which expert consultations are conducted, and this is related to the need for increased transparency through the provision of scientific advice. This series also provides a historical perspective on the evolution of science in relation to the establishment of human nutrient requirements, in addition to providing a medium for the preservation of these significant historical documents. In part, this has become possible due to the highly accessible technology created by CD-ROMs and their easy dissemination. FAO recognizes the importance of making publicly available the background documents for all expert consultations, both past and future.

We are pleased to present the first CD-ROM of this series. These background papers and related documents have been reproduced as submitted by the participants in the Ad Hoc Committee of Experts on Energy and Protein: Requirements and Recommended Intakes held in Rome from March 22–April 2, 1971, and the Expert Consultation on Energy and Protein Requirements held in Rome from October 5–17, 1981.

For more information regarding this CD-ROM series or to request a copy, contact the FAO at:

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International Food Policy Research Institute (IFPRI) *2004–2005 Annual Report* and CD-ROM

IFPRI's *2004–2005 Annual Report* gives a full picture of the Institute's research, capacity-strengthening, and communication activities over the past year. Highlights include three essays on China and India, which are now among the world's fastest-growing economies. Joachim von Braun, Ashok Gulati, and Shenggen Fan consider agricultural strategy and the transformation of the two countries. Montek S. Ahluwalia examines the role of agriculture in alleviating poverty in India. And Jian Liu reviews China's experience with reducing poverty. A CD-ROM, also available, contains IFPRI publications published in 2004, the annual report, and other published works by IFPRI authors, such as journal articles and working papers. To order, visit http://www.ifpri.org/pubs/pubs.htm#areport.

In memoriam

Sara J. Closa, 1929–2006

Dr. Sara J. Closa died on March 25, 2006, in Buenos Aires. .She was born on Nov. 7, 1929, in San Luis, Argentina. She graduated from the School of Pharmacy and Biochemistry, University of Buenos Aires, from which she also received her Ph.D. in Nutrition. Her professional career was long, highly respected, and productive.

Dr. Closa is best known for her important contribution to the organization of ARGENFOODS, the national chapter of INFOODS, the International Network of Food Data Systems. INFOODS was developed by the United Nations University and the Food and Agriculture Organization (FAO), with objective of making all food composition data available worldwide. She was the president of the Executive Committee of ARGENFOODS from its creation in 1997 until 2003, and carried out intensive work on food analysis and the compilation of pre-existing data. This work made possible the updating of the Food Composition Table in Argentina, and contributed to the comprehensiveness of the Latin American one.

Dr. Closa was instrumental in establishing the career path of Food Engineering in the University. She was an active member of several scientific societies, such as the Latin-American Society of Nutrition (SLAN); the Argentine Chapter of SLAN (CASLAN), which she chaired between 1988 and 1991; and the Argentine Association of Food Technologists (AATA).

Beyond her scientific contributions, Sara J. Closa excelled as a teacher, was known for her honesty and dedication to her work, her enthusiastic spirit, and a great personal warmth that will remain in the memories of everyone knew her.

Elizabete Wenzel de Menezes
President, LATINFOODS

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