FOOD AND NUTRITION TECHNICAL ASSISTANCE

Strategies, Policies and Programs to Improve the Nutrition of Women and Girls

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EXECUTIVE SUMMARY

The purpose of this document is to summarize the rationale for improving women's nutrition, emphasizing a life cycle approach, the experiences of the various program options that have been put in place, and the opportunities for policies and programs to improve the nutrition of women and girls.

Rationale for improving women's nutrition

Poor nutrition in infancy and early childhood increases the risk of perinatal, infant, and child morbidity and mortality, long term physical growth, cognitive development and future learning capacity, school performance and educational outcomes, work performance, and reproductive outcome. These are outcomes of an intergenerational cycle of ill health and growth failure, which are compounded where there is gender discrimination in childcare, feeding, and health care. Securing adequate nutrition of women is, therefore, a socially and economically important goal for developing countries.

Availability of efficacious nutrition-related interventions

Infancy and early childhood (<24 months): Maternal nutritional status influences prenatal growth; thus, birth size and stature in early childhood. Inadequate feeding, a low quality diet, and frequent illness result in undernutrition. While there is some tendency for catch-up growth among children born with a low birth weight, the deficits can persist. Food supplementation can accelerate the growth of stunted infants but responses are only likely for children below 2-3 years old. Diarrheal diseases, worms, and possibly *Helicobacter pylori* infection also compromise growth in length. Increased energy and nutrient intake among children under 2 years old can have significant positive effects on cognitive and motor development that are thought to be additive rather than synergistic.

Childhood (2-9 years): Maternal nutritional status is a determinant of chronic and acute nutritional status in children under 5 years old. The nutritional status of 2-9 year old children is often compromised by dependence on a poor diet and repeated bouts of infectious disease and parasites. Vitamin A supplementation is unlikely to affect linear growth, but the situation is equivocal for iron supplementation of preschool and primary school children growth. Zinc supplementation has a greater effect on weight than height, and the effect is greatest among the children who are most zinc deficient or most stunted. Psychological development may improve with a combined preschool nutrition and stimulation intervention. Improved physical growth has occurred in preschool and school age children after deworming. Deworming can also improve iron status and prevent moderate and severe anemia. Malaria control using bed nets can reduce the prevalence of anemia in young children and improve growth.

Adolescence (10-19 years): Stunting after early childhood persists in some populations, but almost complete catch-up growth has been reported in others. Catch-up growth may be associated with delayed menarche and a longer period of growth. Delayed menarche reduces the time interval between menarche and sexual exposure; thus, leaving less time for optimal physiological and anatomical maturation before pregnancy. Because skeletal development is not completed until a few years post menarche, the risk of cephalopelvic disproportion can be important issue where chronic undernutrition is widespread.

Little is known about the long-term effects of nutrition supplementation on ultimate adult height. Catch up growth in adolescence may increase nutritional risk because it reduces stores of critical micronutrients such as iron and vitamin A. Micronutrient deficiency may limit growth during adolescence.

Women of reproductive age (20-49 years): Chronic energy deficiency can increase the risk of infection, reduce activity, and lower productivity. Except in extreme situations, increased energy intakes have a negligible effect on worker productivity among undernourished individuals. Iron deficiency anemia has been associated with reduced physical work capacity.

Pregnancy: The nutrition depletion syndrome can result in delivering low birth weight babies, babies with birth defects, and increased risk of maternal mortality. First trimester maternal anemia is deleterious to fetal development and may cause reduced fetal and newborn infant iron storage. No iron supplementation studies have shown improvement in any relevant index of public health.

Chronically undernourished or stunted women are at higher risk of delivering preterm and of obstructed labor due to cephalopelvic disproportion. Food supplementation programs may have a significant beneficial effect on birth weight in women who are genuinely at risk as a result of an inadequate diet. Supplementary feeding of pregnant women has a strong and consistent positive effect on the motor development of infants. Increased maternal birth weight and length has been associated with greater infant birth weight and length. Secular studies of birth weight showed an increase across generations with no adverse effects reported.

Lactation: Severely undernourished women do not have adequate capacity to sustain prolonged lactation. Supplementary feeding of lactating women has been shown to have a strong and consistent positive effect on motor development of infants. Postpartum vitamin A supplementation is beneficial and safe for both the mother and newborn baby.

Post reproductive age (49+): Undernutrition is a significant problem in the elderly and is associated with poor functional ability as well as mobility. Older people are at greater risk of cardiovascular disease, diabetes, and osteoporosis. Postmenopausal osteoporosis may be associated with calcium intake in childhood.

Increased opportunities for programs and policies

Strategies to improve the nutrition of girls and women of reproductive age need to go beyond the conventional approach of providing services to pregnant women though the traditional maternal and child health care programs. This means that greater effort needs to be placed on nutrition-related behavior change that can be integrated with other health and non-health programs.

Infancy and early childhood (<24 months): Increasing complementary food intake in program settings can reduce undernutrition in late infancy, but the perceived and real barriers must first be identified for programs to be effective. Controlling anemia through a food-based approach rather than a pharmaceutical approach including, e.g., through the use of microencapsulated sprinkles and complementary food fortification, need to be further explored. With the advent of the roll-back malaria program, promotion of the use of insecticide impregnated bed nets for young children to control malaria vector transmission can be important for anemia control and growth as well as malaria control.

Little is known about the influence of traditional or modern child care strategies in child nutrition and development, which is important for planning, implementing, and evaluating programs and in educating mothers about the benefits and limitations of each method. Work is needed in this area as well as how these strategies fit in with the nutrition-related child survival interventions.

Childhood (2-9 years): Interventions that improve both physical growth and psychological development have a greater effect than either alone in populations at risk of undernutrition and poverty. They also influence care giving positively. Unless behavior change programs deal with participants' perceived needs, and include vital concerns that can motivate people to take action, the programs are unlikely to be successful. Programmatically, care givers maybe more motivated to participate in combined programs that provide information and activities related to child psychological development, i.e. the positive deviance and HEARTH model approach.

The single most important factor in determining a child's health and nutritional status is its mother's level of education; thus, educating mothers-to-be is one of the best ways of ensuring the nutritional future of the next generation. This can begin with early childhood learning centers where activities to improve psychological development as well as deliver micronutrient supplements and anthelminths can be implemented. The latter can also be delivered through primary schools, along with school gardens, awareness about controlling malaria, and nutrition and health education. Where institutional feeding is provided, the potential exists to provide fortified food be it in a meal or as a snack food. Where no feeding program exists, community mobilization activities can be implemented to educate parents about the need for children to take a meal to school. Because not all children go to school, child-to-child nutrition-related activities, need to be explored further and tested, especially where many girls do not go to school, such as in India.

Adolescents (10-19 years): Iron deficiency anemia can be corrected with iron supplementation, which can improve cognitive function in deficient adolescent girls. Well-supervised intermittent iron supplementation through schools or the workplace can reduce their prevalence of anemia, but this supplementation cannot build sufficient stores to substitute for the need for iron supplements in pregnancy. The few activities targeted to this age group center around HIV/AIDS awareness and education, including the prevention and management of STDs. Basic nutrition is taught as part of life-skills training in some schools. There is scope to expand deworming and micronutrient supplementation within educational settings. Supplementary food can also be provided through school meals to induce growth; increase school attendance; and serve as an excellent opportunity for nutrition and health education relevant to the age group. There are few opportunities to contact adolescent children who do not go to school. Additional work is needed to identify effective ways to reach these adolescents with nutrition-based behavior change messages that are perceived to be relevant to their lifestyles. This will require sensitizing communities to the health and nutritional needs of adolescents, gaining community and parental support for action, as well as identifying the perceived needs of the girls themselves.

Women of reproductive age (20-49 years): Food security projects targeted to households, need to develop more comprehensive behavior change activities that are life cycle focused rather than targeted only to infants and young children or pregnant women. Similarly, health-based interventions such as family planning and longer birth spacing need to include issues related to improving the nutritional status of the woman. Nutrition could also be better integrated with the prevention and management of reproductive tract infections and STDs because reduced infection rates are likely to improve nutritional status.

Pregnancy: Prenatal programs need to focus on identifying and counseling pregnant women on appropriate care and nutrition that build on the perceived priorities of mothers. Malaria chemoprophylaxis, especially among primigravidae, and deworming need to be encouraged in areas where these parasites are public health problems. More emphasis is needed on the quality of care provided, including that related to nutrition and behavior change. Where supplementary food to at-risk and undernourished women is provided, efforts are needed to identify these women and begin supplementation as early as possible during pregnancy. The provision of post-partum vitamin A supplementation needs to be incorporated as part of delivery care programs.

There is little evidence that a daily iron supplement program works, largely because of operational constraints, but it is important. Overcoming the operational issues through better logistics and training of health care providers may improve program effectiveness.

Lactation: Postnatal programs include counseling on nutrition and family planning. The two programs need to be integrated better and promote positive health and nutrition practices for females of all ages.

Post reproductive age (49+): Older people in developing countries often contribute to household food security. They also contribute by nurturing grandchildren and other young relatives, and this is becoming increasingly important in countries where HIV/AIDS is widespread. Within the context of both child survival and food security projects, there is scope to improve outcomes if there was a better understanding of the role of the elderly in childcare and as providers of food.

At the policy level there are 6 main areas that affect all stages of the life cycle namely: commitment to improving women and girls nutrition throughout their life; better integration of health services and programs within the health sector; promoting inter sectoral collaboration that results in positive behavior change and increased energy and nutrient intake; measuring the quality of care and services provided; disaggregating outcome data by gender; and identifying the nutritional needs of adolescents and the elderly.

Women's nutrition remains a global issue with common problems and constraints that will only be resolved if women's health and nutrition are put in the context of the life cycle rather than in discrete compartments. This includes addressing the underlying sociocultural determinants of behaviors connected to women's nutrition at all stages of the life cycle.

STRATEGIES, POLICIES, AND PROGRAMS TO IMPROVE THE NUTRITION OF WOMEN AND GIRLS

1. INTRODUCTION

Many of the 200 million women who become pregnant each year, most of them in developing countries (WHO 1997), suffer from both ongoing nutrition deficiencies and the long-term cumulative consequences of undernutrition during childhood. Poor health and nutrition are associated with repeated, closely spaced pregnancies that progressively reduce women's nutritional reserves to the point of nutritional depletion known as the maternal depletion syndrome (Jellife 1966; Jellife and Maddocks 1964; Merchant and Martorell 1988). Over 10 years ago, Leslie et al (1988) noted that much emphasis had been placed on this syndrome but little attention had been given to the interrelationships between reproductive health and the socio-biological context in which these experiences take place. The same situation applies today. Pregnancy-related health and nutrition problems affect a woman's quality of life and her productivity[1], that of her newborn infant well beyond delivery, and that of her family and community as a whole. Thus, the nutrition status of women throughout their productive life, and not just during pregnancy, is extremely important.

Undernutrition in women, including pregnant women, however, is not conspicuous and remains largely uncounted and unreported; thus, insufficient attention has been given to its extent, causes, and consequences (Tinker and Koblinsky 1994). Because of this, few resources have been allocated to improving women's nutrition compared with other nutrition and public health actions (Leslie 1991). Existing data and program experiences come mostly from small-scale efforts to improve nutrition during pregnancy, often through nutrition supplementation to enhance fetal growth and birth weight or to reduce the adverse consequences of maternal anemia (Gulmezoglu et al 1997; de Onis et al 1998b). Highly publicized initiatives such as 'child survival' and 'safe motherhood' have been said to have had less impact than expected because too little attention was given to the nutrition status of mothers or women (Tinker et al 1994). This lack of emphasis on women's nutrition is significant given its importance to women's health, pregnancy outcome, and child survival; the availability of efficacious nutrition-related interventions that benefit women per se; and the increased opportunities for policies and programs that can be set up through existing systems in most developing countries. The purpose of this document is to summarize the rationale for improving women's nutrition, emphasizing a life cycle approach, the experiences of the various program options that have been put in place, and the opportunities for policies and programs to improve the nutrition of women and girls. This is followed by a section on indicators that measure or have the potential to measure program effectiveness.

2. CONSEQUENCES AND EXTENT OF POOR WOMEN'S NUTRITION

[1] Productivity is defined in its broadest sense and includes ability to work efficiently and effectively, and to provide adequate child care.

The definitive negative outcome of poor health[2] and nutrition among women is a high prevalence of maternal mortality; nearly 600,000 women in developing countries die each year from pregnancy related causes (WHO/UNICEF 1996). The global maternal mortality rate is 460 per 100,000 live births: 500/100,000 live births developing countries compared with 10/100,000 live births in developed countries (Table 1). Within the developing world, however, there are huge regional variations—from 140/100,000 live births in Central America to 1,080/100,000 live births in Eastern Africa (Population Reference Bureau 1998). Adolescent girls are at two to five times greater risk of maternal mortality than other women of reproductive age (Tinker and Koblinsky 1994). Indeed, of all the human development indicators, the greatest disparity between developed and developing countries is for the risk of maternal mortality (WHO/UNICEF 1996). Although poor prenatal nutrition contributes directly and indirectly to this large death toll (Population Reference Bureau 1998), the extent of its contribution has not been quantitatively established because the main reported causes of maternal mortality[3] greatly overshadow the role of nutrition itself.

The extent of women's malnutrition, even among pregnant women, in developing countries is difficult to estimate because few nationally representative studies have been done. This is compounded by the lack of a consensus on the appropriate indicators and reference standards for women, which continue to be debated. Nationally representative demographic and health survey data show that between 1-20% of non pregnant women were chronically energy deficient[4] (Loaiza 1997). The World Bank (1994) estimates that 450 million adult women in developing countries are stunted due to undernutrition during childhood. Using 1985 data, Leslie (1991) conservatively estimated that about 250 million women in the same countries were at risk of Iodine Deficiency Disorders (IDD), and almost two million were blind due to vitamin A deficiency (VAD). VAD is more frequent in Asia and Africa (WHO 1995) and in endemic areas night blindness has been observed to be 5-25 times more frequent in pregnant women than in preschool children (IVACG 1997; Katz et al 1995), suggesting women's increased vulnerability to vitamin A deficiency during times of increased requirements. Using 1998 data, and DeMaeyer's (1985) assumption that 59% of pregnant women and 47% of all women are anemic, over 745 million of the more than 1,514 million women of childbearing age (15-49 years) would be anemic. Prevalence rates for anemia are greater in Asia and in Africa (UN 1992) compared with Latin America (Mora and Mora 1999) (Table 1). IDD and iron deficiency are known to affect females throughout infancy and childhood disproportionately, as well as before and during pregnancy.

3. CONCEPTUAL FRAMEWORK

Both the magnitude of female undernutrition and the enormous social, economic, health and development implications of poor female nutrition provide a compelling rationale for systematic

[2] Including inadequate care during pregnancy and delivery.

[3] Hemorrhage, obstructed delivery, eclampsia, sepsis, and unsafe abortion.

[4] Defined as a body mass index (BMI) below 18.5.

stronger action. Because of both the reproductive consequences and the long term effects of childhood malnutrition on adult physical and intellectual productivity, as well as the widespread impact of women's health and nutrition on child survival, women's productivity, family welfare, and poverty reduction in the community as a whole, securing adequate nutrition of women, particularly before and during pregnancy, is a socially and economically important goal for developing countries.

Throughout their life cycle, women's health and nutrition is affected by complex socio-cultural, psychological, biological, and health service-related factors that are highly interrelated. Figure 1 outlines a conceptual framework, adapted from Tinker et al (1994) that identifies four critical points for action.

Figure 1. Determinants of women's health and nutritional status

```
          ------------------------ Social, economic and --------------------
          |                          cultural factors                      |
          |                                |                               |
          |                                |                               |
Individual behavior and ------  Women's health and  -------- Health and nutrition
  psychological factors          nutrition through life            services
          |                                |                               |
          |                                |                               |
          ------------------------Biological factors--------------------------
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Specifically:

- Social, economic, and cultural factors that include social status, female discrimination, fertility patterns (e.g., pregnancy intervals, teenage pregnancy, unplanned pregnancies), that influence both exposure to and consequences of disease;

- Individual behavior and psychological factors including dietary practices, reproductive patterns, health seeking behavior, and use of health and nutrition services;

- Biological factors (age of menarche, menstruation, pregnancy, and increased risk of infections); and

- Access to, quality of, and quantity (coverage) of health and nutrition services.

To have an impact on women's health and nutrition status, programs that are socially, economically, culturally, and biologically appropriate are needed throughout the female life cycle, beginning as early as possible. In other words, women's health and nutrition has to be considered as part of an intergenerational continuum. Two practical conclusions need to be emphasized. First, the consequences of women's undernutrition on child survival and development are at least as important as the direct biological effect of undernutrition on the fetus during pregnancy and infant during lactation. Second, focusing on nutrition during pregnancy ignores the more fundamental problem of women's nutrition throughout their life, of which pregnancy-nutrition is only a small but an important contributory factor. This is significant because nutrition status, unlike disease, is cumulative over time and is not an isolated incident (Merchant and Kurz 1993). Youssef (1990) notes that too much of the nutrition literature focuses on maternal health, maternal depletion, and maternal mortality as either causes, consequences, intervening mechanisms, or indicators of poor nutritional status that are too simplistic and detract from important interventions that are not maternally related. She also points out that child bearing and breast-feeding can contribute significantly to poor health because of their associated nutritional stresses, and exacerbate the other factors that predispose women to undernutrition.

4. NUTRITIONAL RISKS THROUGHOUT THE LIFE CYCLE: INTERGENERATIONAL ISSUES

Poor nutrition in infancy and early childhood increases the risk of perinatal, infant, and child morbidity and mortality because of reduced immune competence, and also affects long term physical growth (Scholl et al 1990; Bhatia and Seshadri 1993; Martorell et al 1998), cognitive development and future learning capacity (Nokes et al 1998), school performance (Grantham-McGregor 1992; Nokes et al 1998) educational outcomes, work performance (Hallberg and Scrimshaw 1981), and reproductive outcome (Neumann and Harrison 1994). The girl child may experience discriminatory child care, feeding, and health care that can result in malnutrition including micronutrient deficiencies. Data from 43 national level surveys, however, do not show gender differences in nutrition status, which may be because adjustments were not made for gender-based biological (disadvantage boys) and socio-cultural disadvantages (trend against girls) that are not necessarily equal (Kurz and Johnson-Welch 1997). Kurz and Johnson-Welch also summarized health data disaggregated by gender from 130 published articles, in which they found that girls were worse off than boys for topics related to mortality and health care utilization, but the number of studies were small at 6 and 8, respectively. The authors note that the common ways in which gender bias manifests itself is that girls tend not to be taken for health care as often or as early in their illness as boys, girls may receive less or poorer quality food than their brothers, and girls may receive less attention from parents.

An intergenerational cycle of ill health and growth failure has been described, in which undernutrition in childhood leads to small body size in adulthood. Genetic and environmental influences affect both maternal height and prepregnancy weight, both of which are important determinants of birth size (Kramer 1987). Malnourished women, i.e., women who are short, underweight, do not gain sufficient weight during pregnancy, and/or who are anemic, are more likely to have miscarriages or still births, deliver intrauterine growth retarded (IUGR) or low birth weight (LBW) babies (Adair 1987; Scholl and Hediger 1994; Lechtig and Shrimpton 1997) which, in turn, are linked to increased risk of perinatal and infant mortality (Lettenmeier et al 1988; Chatterjee and Lambert 1989; Viteri 1994; Sachdev 1997). LBW and IUGR are not independent because birth weight is affected by IUGR and gestation duration; thus, both conditions need to be optimized to reduce the prevalence of LBW. Globally, about 15% of all babies are born with a LBW—over 2.5 times more so in developing (16%) than in developed (6%) countries (de Onis et al 1998a)—and the overwhelming majority are due to IUGR and not preterm delivery. Nevertheless, prematurity is a significant problem, particularly in Asia, and its contribution to LBW cannot be ignored (Sachdev 1997).

This section discusses the nutritional risks for the different life-cycle groups. The age boundaries are based on age groups to which interventions can be targeted. Much of the literature on risk factors straddles these age groups; thus, the information has been summarized under the age group that interventions can be more readily targeted to.

Infancy and early childhood (<24 months)
Maternal nutritional status influences prenatal growth, which affects birth size and stature in early childhood. Poor intrauterine growth and development as well as preterm births result in LBW and these babies are particularly vulnerable to undernutrition (and dying amongst other things). Sub optimal breastfeeding, an inadequate and low quality diet, and frequent illness are known to result in undernutrition, including micronutrient deficiencies. In some cultures, preferential care and feeding is given to male infants and young boys.

There is some tendency for catch-up growth among children born with a LBW, but the deficits can persist even up to 12-14 years (Bhargava et al 1995; Adair 1999). Both Bhargava et al and Adair found that children at greatest risk of long-term stunting were LWB infants who were also severely stunted during infancy.

Food supplementation has been shown to accelerate the growth of stunted infants and children (Lutter et al 1990; Husaini et al 1991; Walker et al 1991), and to reduce the harmful effect on infection and growth (Lutter et al 1989; Walker et al 1992). Beaton (1993) reviewed some of the experiences of intervention programs on physical growth and concluded that, while growth responses can be generated among children up to 3 or more years old, these do not appear to represent true catch-up growth. Instead, they might be called 'damage control' or prevention of further losses. Beaton questions whether by not intervening in this age range growth faltering marks a real departure from genetic potential. He postulated that early growth failure may permanently alter an individual's potential to grow, i.e., enables true catch-up growth, while later insults may be more amenable to recovery given a favorable environment. He notes the cause of growth failure may be a critical determinant of subsequent responsiveness, which may explain why children with acute undernutrition or other severe illnesses respond better to feeding than children with general growth faltering. Two more recent reviews of growth and stunting in developing countries (Golden 1994; Martorell et al 1994) also concluded that both the effect of adverse environmental conditions and their improvement might be greatest in the first few years of life.

Maternal micronutrient status may also have an effect on growth of young offspring. In a longitudinal study in Malawi, maternal vitamin A deficiency was related to linear and ponderal growth of children after adjusting for confounding factors, including gender and maternal body mass index. At 1 year of age, children of vitamin A deficient mothers were shorter and lighter than the children of non deficient mothers (Semba et al 1997). Aukett et al (1986) found that supplementing 17-19 month old anemic children with iron for two months resulted in a greater rate of weight gain compared with controls.

Only one study (Rosado 1999) was found in the literature that looked at the effect of multiple micronutrient[5] supplementation on growth of children in a double-blind community-based randomized trial. Treatment was administered to 8-14 month old children for 6 d/wk over 12 months under supervision. Final length in the supplemented group was 0.6 cm greater than in the placebo group after controlling for age, initial length, sex, and socioeconomic status. Nevertheless, the effect was lower than expected for catch-up growth, which led the authors to suggest that supplementation with more than the apparently deficient micronutrients was required. Allen (1994a) in her review on nutrient deficiencies and linear growth faltering noted single nutrient supplementation has not had the effect on growth that would be expected if that nutrient was limiting. She too suggests that multiple rather than single growth-limiting nutrient deficiencies coexist in children.

Growth in length is also compromised by environmental health issues, including common childhood infections, particularly diarrheal diseases (Stephensen 1999, Martorell et al 1975). Moreover, a child born in the poorest countries can expect to be infected with worms as soon as she or he can crawl, and to remain infected and re-infected for the rest of her or his life (C. Maier, personal communication 1999). One study has shown that infants with sustained *Helicobacter pylori* infection grew less well than those without (Dale et al 1998), while others have not (Vaira et al 1998). The adverse effect of chronic and acute infections on linear growth may result from micronutrient malnutrition or the induction of the acute-phase response and its consequences that can affect long bone growth (Stephensen 1999).

In addition to growth, nutrition is important for psychological development. A recent WHO (1999) review concluded that increased energy and nutrient intake among children under 2 years old had significant positive effects on cognitive and motor development. A study in Jamaica that included stunted and non stunted children age 9-24 months randomly assigned to control, supplementation, stimulation, or combined supplementation and stimulation found that supplementation with or without stimulation improved growth in both weight and height in the first 6 months and these gains were sustained over the next 6 months. The younger and thinner children benefited most. All 3 intervention groups showed consistent improvements in a total development quotient throughout the 2 years, with the combined intervention having the greatest benefit that was close to the level for non stunted children. The authors concluded that the effects of the combined interventions were additive and not synergistic. A similar study design was used in Colombia. Mothers were enrolled in that last trimester of pregnancy and participated for 3 years. Supplementation had a greater effect on cognitive ability than stimulation alone and there was no added benefit of the combined intervention on psychological development, suggesting the interventions affected different aspects of psychological development (Waber et al 1981). Supplementation alone, but not stimulation alone, had a positive effect on growth and the effect of the combined intervention was greater than that of supplementation alone. The data also showed that this effect was maintained through to the age of 6 years, which the authors thought may have been due to changes in care-giving behavior. Also, the most malnourished children were most likely to benefit (Super et al 1990). The findings from these studies have important

[5] 1 RDA for vitamins D, E, K, niacin, B-1, B-6, folic acid, pantothenic acid, I, Cu, Mn, F, and Se; 1.2 RDA for vitamin A; and 1.5 RDA for vitamins C, B-2, B-12, Fe, and Zn.

implications for the promotion of early childhood care and development programs, which in turn, have implications for the success of educational achievement.

Childhood (2-9 years)
The nutritional status of children 2-9 years old, which includes the large preschool age group that has been the focus of child survival activities, is often compromised by dependence on a poor diet and repeated bouts of infectious disease and parasites. Among this age group too gender discrimination in food and health care exists in some cultures.

An analysis of national level Demographic and Health Survey (DHS) data from 10 sub-Saharan countries found maternal nutritional status was a very important factor for both chronic and acute nutritional status among children less than 5 years old, whatever the age interval, after controlling for parental demographic and socio-economic factors, prenatal care, breastfeeding, child age, and immunization status. Better nutritional status of the mothers lowered the probability of the child being stunted at all ages below 5 years old and the odds of being wasted among children more than six months old. Rutstein (1996) suggested that maternal nutritional status in the DHS may have been a proxy for food availability and/or the mother's ability to provide child care.

Few data exist to show catch-up growth beyond the age of 2-3 years. In the Philippines, Adair (1999) found the potential for catch-up growth among a cohort of children 2-12 years old was greatest among those with increased growth potential, marked by taller mothers, longer birth length and lower ponderal index6 at birth, and less severe stunting during early infancy.

The effect of single micronutrient supplementation on growth has also been studied. Vitamin A supplementation had no effect on linear growth among either preschool boys or girls in randomized supplementation trials in Indonesia (West et al 1988), India (Rahmathulla et al 1991), or the Sudan (Fawzi et al 1997). Among preschool and primary school children growth was improved after 8-15 weeks of iron supplementation (Chwang et al 1988; Latham et al 1990; Angeles et al 1993), although Gershof et al (1988) and Migasena et al (1972) did not get the same findings in their preschool children. Angeles et al attributed the improvement in growth to reduced morbidity following iron supplementation. Allen (1994a) suggests the mixed results may reflect the short duration of the intervention. Alternatively, the treatment effect may only occur if the child was initially anemic and not all studies had these data. In a meta analysis of 25 zinc intervention trials on children 0-13 years of age (mean 3.6 years), Brown et al (1998) found that zinc supplementation had a greater effect on weight (0.26 SD units) than height (0.22 SD units) (both significant), after controlling for age. The effect of zinc was greatest among the children who were most zinc deficient or most stunted.

Pollitt and Perez-Escamilla (1995) looked at the effect of preschool participation with and without previous and ongoing nutrition interventions compared with the control group. Psychological development improved with the interventions and persisted one year after its

6 Kg/cm^3 below the 10^{th} percentile.

completion. Children exposed at a younger age and for a longer duration showed greater gains in cognition and physical growth than other children. Supplementation alone before starting preschool had no effect on psychological development, whereas the combined intervention had the greatest effect.

Helminth burdens are most intense during the years of schooling (Bundy 1990). Single and multiple helminthic infections have been shown to be associated with growth retardation (Latham et al 1990) and catch-up growth has occurred in preschool children after deworming (Nabarro 1988, Hlaing 1993). Deworming preschool and school-age children has been shown to improve physical growth (Aswathi et al 1995; Bundy and Guyatt 1996). Where hookworm is heavily endemic, primary school deworming programs can also improve iron status and prevent moderate and severe anemia, but deworming may be needed at least twice yearly (Stoltzfus et al 1998). Malaria control using bed nets has also been shown to reduce the prevalence of anemia in young children (Premji 1995) and to improve growth (D'Alessandro 1995).

Adolescence (10-19 years)
Adolescence is an intense anabolic period where requirements for all nutrients increase; thus children between 10 and 19 years are vulnerable to undernutrition if their food intake is not sufficient to meet the increased demands for rapid growth and development. This situation is compounded where girls become mothers before their own growth ceases. As with all other age groups, adolescents are often exposed to infections and parasites that can compromise nutritional status. Among those sexually active, there is an increased risk of infection from sexually transmitted diseases.

Stunting after early childhood persists in some populations, but almost complete catch-up growth has been reported in others. Among poor rural adolescent Kenyan children, complete catch-up growth was associated with a 2-3 year delay in menarche, which may have been causally related to the catch-up growth (Kulin et al 1982). Similarly, the attained adult heights of undernourished, growth-retarded, menarche-delayed American girls were identical to those of control children, which was thought to be linked to their longer period of growth compared with the controls (Dreizen et al 1967). Historical records show the mean heights of American female slaves though to 14 years of age were at the second centile of the NCHS standards. By 17 years old, they were at the 21.5 centile, by 22 years old at the 29.5 centile, and after 25 years of age at the 34.5 centile (Steckel 1987)[7]. A longitudinal growth study on stunted Indian girls found those most growth-retarded at 5 years of age remained most growth-retarded at 18 years old (Satyanarayana et al 1981). Nevertheless, Rush (in press) points out that there was an inverse relationship between the increment in growth between the age of 5 and 18 years and height at 5 years old, such that the extreme intergroup discrepancy of 14.2 cm fell to 7.3 cm, suggesting catch-up growth.

H. pylori infection has been associated with growth delay in Italian children 8.5-14 years old

[7] These findings support Fogel's (1999) "techno-physio evolution" hypothesis. In other words, as human beings gain control over their environment, their body size increases as does the robustness and capacity of their vital organs.

(Perri et al 1997). A study in Glasgow (Patel et al 1994) found that growth in height between 7 and 11 years old was diminished in infected children by a mean of 1.1 cm (0.3 to 2.0 cm) over four years and this growth reduction was largely confined to girls (1.6 cm over four years). This led the authors to conclude that the greater reduction of growth among infected girls raises the possibility that *H. pylori* infection may delay or diminish the pubertal growth spurt. *H. pylori* infection is thought to be widespread in developing countries although prevalence data are not readily available (L. Davidsson personal communication 1999).

In a longitudinal study of Bangladeshi women first seen in 1976-77 when they were perimenarcheal, and again a decade later, there was a strong inverse relationship between height and age at menarche (Riley 1994). The tallest girls had the earliest menarche. After 10 years, however, adult height was essentially unrelated to age at menarche suggesting that girls with late menarche grew for a longer period than girls with early menarche and achieved almost complete catch-up growth. Thus, catch-up growth among the undernourished, where it occurs, may be associated with delayed puberty and a much longer period of growth than in well nourished populations. Delayed puberty has also been reported in LBW children (Bhargava 1980; Fledelius, in Sachdev 1998), although Bhargava (1995) also documented an earlier onset of menarche in a longitudinal study.

Late menarche can have another significance, as in the Bangladesh population (Rush, in press). For many young women menarche is associated with marriageability; thus, exposure to pregnancy. Smaller girls with later puberty were observed to be married-off later and the probability of early marriage was strongly related to greater height (and weight) in late childhood. Delayed growth in this context offered some protection against the potential deleterious effects of early pregnancy.

While little is known about the mechanisms of catch-up growth in early childhood, even less is known about the long term effects of nutrition supplementation on ultimate adult height. Attained adult height is a function not only of the velocity, but also of the duration and timing of growth. Data are available on nutritional rehabilitation and acceleration of linear growth, but few relate nutritional rehabilitation to adult height. One of the best documented studies describes the effect of prenatal and early childhood nutrition supplementation in four villages in Guatemala (Schroeder et al 1995). Differences in adult height were related to the age of supplement intakes, to whether children received a high protein supplement (*atole*) or a low protein and low energy drink (*fresco*), and to the incremental energy consumed from these supplements. Ultimate attained linear growth in the two *atole* villages was 0.9 cm greater per year of supplementation among those who took supplementation from 3 to 12 months of age; 1.0 cm per year greater if supplementation was taken from 12 to 24 months of age; and 0.4 cm greater per year where supplementation was taken from 24 to 36 months of age. No association was observed between height and supplementation from 3 through 7 years of age.

Martorell et al (1990) studied growth in the same Guatemalan population between 5 and 18-to-26 years of age. They concluded that the gain in height and fat-free mass, especially in females, from 5 years to adulthood was independent of height at 5 years of age; thus, all the differences in adult height associated with the preschool nutrition supplementation were in place by age 5 and later increments in height were independent of earlier supplementation. While height increments from 5 years to adulthood in these poor rural Guatemalan villagers were similar to those measured in a population study in Berkeley, California (Tuddenham and Snyder 1954), supplementation was stopped in the Guatemalan study after the age of seven years; thus, determining whether nutritional supplementation after that age might have led to increased adult height was not possible.

Growth changes among previously undernourished children following adoption or marked improvement in social and environmental conditions have often been observed (Winick et al 1975; Lien et al 1977; Schumacher et al 1987; Yip et al 1992). Few studies, however, have followed the adoptees into adulthood. Several studies are available on the growth of undernourished children from developing countries adopted into wealthy families. Stunted Peruvian children, adopted early in life, caught up in height with the Boston reference standards (Graham and Adrianzen 1972). Proos et al (1991a; 1991b; 1992) and Proos (1993) observed that 62% of poor Indian girls, 81% of whom has been LBW infants, were stunted when adopted into wealthy Swedish families at and average age of 9.3 months. After adoption growth was accelerated and within two years 20% of the children remained stunted, although the interindividual differences that existed at birth remained. Just before puberty the children were only 0.3 standard deviation units shorter than NCHS means. The mean attained adult heights, however, were 1.4 standard deviation units below NCHS means and were most likely due to the hastened onset of menarche (11.6 years compared with 13.0 years for contemporary Swedish girls and 14.4 years for rural Indian girls), which cut short the period of rapid premenarcheal growth. Proos et al's study shows early accelerated growth, following improved environmental circumstances, was associated with minimal increases in attained adult height. As Rush (in press) notes, this suggests the effect of IUGR (and the resulting LBW) cannot be entirely reversed even in ideal environments and with nutritional inputs in post natal life.

Vitamin A and iron deficiencies are thought to be common in non pregnant adolescents. Among Malawian girls between 10-19 years old, Fazio-Tirrozzo et al (1998) found just over 25% were sub clinically severely vitamin A deficient, while 40% had a modified response dose rate indicative of low liver stores[8], close to 90% were anemic, and 60% had low tocopherol levels[9]. Vitamin A levels were significantly related to increased age, with younger girls more likely to be deficient, and stunted girls were more likely to have low serum retinol levels. This they thought may have been related to the timing of menarche. Ahmed et al (1997) conducted a study among 12-19 years old female factory workers in Bangladesh. Overall, the girls were not wasted and no information was provided on their stature. Just over 55% of the girls had sub clinical vitamin A deficiency[10], of which about 14% were sub clinically severely deficient[11], and about 45% were

[8] >0.060.

[9] Serum tocopherl <11.5 Fmol/L.

[10] Serum retinol < 1.05 Fmol/L.

[11] Serum retinol < 0.70 Fmol/L.

also anemic[12]. Multiple regression analysis showed that hemoglobin concentration, frequency of intakes of dark green leafy vegetables, menstruation at the time of the survey, and age were significantly and independently related to serum vitamin A level. Iron supplementation trials among adolescent girls have shown improved iron status indicative of deficiency (Bruner et al 1996; Katelhut et al 1996; Angeles-Agdeppa et al 1997; Smitasiri and Dhanamitta personal communication 1998).

Brabin and Brabin (1992) suggest that the process of catch up growth in adolescence may increase nutritional risk because it reduces stores of critical micronutrients such as iron and vitamin A. Based on the studies showing improved growth following iron supplementation, they postulated that iron is an essential nutrient for skeletal growth and deficiency may limit growth during adolescence. Similarly, based on data from Swedish adolescents showing an association between serum retinol and puberty level, they suggest vitamin A is important for sexual maturation and deficiency can cause menstrual irregularities, such as menorrhagia, and contribute to anemia. Ilich-Ernst et al (1998) carried out a longitudinal study to look at, among other things, the simultaneous effect of growth and menarche on iron stores in adolescent girls. They found the adolescent growth spurt and menstrual losses adversely affected iron stores among girls with low iron intakes (<9 mg/d).

A healthy adolescent undergoes a growth spurt 12-18 months before menarche, and they continue to grow in height for up 7 years thereafter; thus, if menarche is delayed, growth can continue into early adulthood. Development of the birth canal is completed two to three years after full height is reached (Moerman 1982). The preceding discussion has shown that poor nutrition can delay menarche. Among adolescents with a delayed menarche, the reduced time interval between menarche and sexual exposure leaves less time for optimal physiological and anatomical maturation before pregnancy. Because skeletal development is not completed until a few years post menarche, the risk of cephalopelvic disproportion is an important issue (Hamilton et al 1984).

In a study on the rate of operative delivery among 13-16 year old primigravidae, Harrison et al (1985) found that fewer girls whose infant's birth weight was 3.0 Kg or less required operative delivery compared with girls who delivered babies with birth weights of more than 3.0 Kg. Teen-age mothers are at increased risk of preterm deliveries, stillbirths, and neonatal deaths (Naeye 1979), which has been attributed to competition between the nutritional requirements of the developing fetus and the requirements for post menarcheal skeletal maturation. Brabin and Brabin (1992) note that even among non pregnant adolescents, chronic undernutrition may put them at increased risk because their bodies are still catching up rather than preparing for the demands of reproduction that lay ahead[13].

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[12] Hb<120 mg/dL.

[13] They also note that this age group has still not acquired adult levels if immunity, and often have high infectious-disease rates, which can compromise their health when they become pregnant.

In some societies, a large number of adolescents are sexually active, resulting in a high prevalence of sexually transmitted diseases (WHO/Family Health/Adolescent Health 1995), such as human immunodeficiency virus (Mann 1992, Shah 1998), syphilis, and Chlamydia (Brabin et al 1995). Some of these diseases are more prevalent in the undernourished and immunocompromised. Improved nutrition may, therefore, not only enhance growth directly but also indirectly by improving the immunologic status of adolescents although data are needed to show this.

Finally, a healthy diet can also contribute to more mobility in older age. For instance, it is likely that childhood and adolescence is a unique time to acquire the strongest possible bones to decrease the risk of osteoporosis in old age (WHO 1998). Low body mass in adolescence is associated with reduced bone mass in early adulthood, which may lead to a greater risk of post menopausal osteoporosis (C. Weaver, personal communication 1999).

Women of reproductive age (20-49 years)

Prepregnancy weight is known to be important for IUGR (WHO 1995). This should not, however, be the primary reason for being concerned about women's nutrition because of their important role as income earners, food producers, and family care takers. The prevalence of chronic energy deficiency (BMI <18.5) can be as high as 15% (Table 2), which has implications for increased risk of infection, reduced activity, and lower productivity (Shetty and James 1994). Among undernourished people, acute disease and illness tend to be more frequent, more severe and of longer duration, providing decreased capacities to perform daily activities. Increased energy intakes, however, have a negligible effect on worker productivity among undernourished individuals except in extreme situations, such as famines (Martorell and Arroyave 1988; Edmundson and Sukhatme 1990). This is because people adapt both physically and socially to low energy intakes; thus, altering the efficiency of converting food energy to physical work.

Iron deficiency anemia has been associated with reduced physical work capacity of heavy as well as sedentary industrial occupations because the transport of oxygen in blood to tissues is impaired. Direct evidence comes from supplementation studies of anemic women in Sri Lanka, Indonesia, and China in which work productivity increased among those supplemented compared with those unsupplemented (Bothwell and Charlton 1981; Hussaini et al 1981; Li et al 1994) and indirect evidence from an observational study in Indonesia (Scholz et al 1997). In contrast, maximum oxygen consumption in iron deficient women without anemia was found to be unrelated to decreased oxygen transport capacity of the blood, but may have been caused by reduced body iron stores (Zhu and Haas 1997). Vitamin A is needed to mobilize storage iron (Mejia and Arroyave 1982; Suharno and Muhilal 1996); thus deficiency could also impair, or further impair, worker productivity and cognitive aspects and are associated with iron deficiency. In an intervention trial among non anemic Bangladeshi women 15-45 years old, Kolsteren et al (1999) found supplementation with iron, vitamin A, and zinc together increased hemoglobin levels significantly by 179 mg/dL, compared with 159 mg/dL for those receiving iron and vitamin a or 134 mg/dL for those receiving iron alone.

Nutrition status can also be affected by sociocultural practices. Studies have shown that female discrimination in developing countries may be to a large extent self-inflicted (Holmboe-Ottesen et al 1989) as a result of a 'self-sacrificing' role that dictates girls and women must meet their own needs last. For example, increased female wages have been associated with improved nutrient intakes of most household members except for that of women themselves (Behrman and Deolalikar 1990).

Pregnancy
The demand for both energy and many nutrients is increased during pregnancy. For well-nourished women, only a small amount of additional energy is required because the body adapts to the increased energy demands and becomes more energy efficient by reducing physical activity and lowering metabolic rate. It is only during the last trimester of pregnancy that average-size well-nourished women require extra energy (Hytten et al 1983). Chronic inadequate food intake on top of multiple pregnancies, however, can result in the nutrition depletion syndrome. This in turn can result in delivering low birth weight babies, babies with birth defects, and increased risk of maternal mortality.

Maternal anemia diagnosed in the first trimester of pregnancy is deleterious to the development of the fetus (Scholl and Hediger 1994; Beard 1994). Moreover, some evidence exists that severe maternal iron deficiency causes reduced iron storage in the fetus and newborn infant, predisposing them to iron deficiency anemia (Scholl and Hediger 1994). No iron supplementation studies, however, have shown improvement in any relevant index of public health, such as lowered maternal morbidity and mortality, improved fetal growth, or lowered perinatal and infant mortality (Gulmezoglu et al 1997; de Onis et al 1998b; Rush in press). Vitamin A deficiency in pregnancy may increase the risk of maternal mortality (West et al 1999) and more data are needed to confirm this.

Chronically undernourished or stunted women have been found to be at higher risk of delivering preterm (Siega-Riz et al 1996) and of obstructed labor due to cephalopelvic disproportion (Harper et al 1995). Demographic and Health Survey data show between 3-40% of non pregnant women are at risk of adverse pregnancy outcomes by virtue of their short stature (<145 cm) and/or low body weight (<45 Kg) (Table 2) (S. Rutstein, personal communication 1998).

Harrison (1990) noted that the association between operative delivery rates and maternal height was strong for primigravidae in a study in Nigeria. Irrespective of birth weight, between 23-56% of women below 1.5 m in height, but 16% with heights above 1.65 m, required operative delivery. In every height grouping, the frequency of operative delivery was much higher (typically double) for a birth weight more than 3.5 Kg compared with lower birth weights. One-half of the women below 1.5 m had operative delivery where birth weights were more than 2.5 Kg, and one-half of the women between 1.5 m and 1.54 m had operative delivery if birth weights were more than 3.5 Kg. Merchant (1991) related the probability of operative delivery to maternal height and newborn head size in an urban population in Guatemala. Head size is important as larger heads can cause mechanical difficulties in delivery among women with cephalopelvic disproportion. Like the Nigerian study, operative delivery was more frequent both with shorter maternal stature and larger infant head size. Among the shortest quartile of women, about one-quarter with newborns whose head circumferences were in the smallest quartile had an intrapartum cesarean. In contrast just over one-half of women of the same height, with infants in the largest head circumference quartile, had an intrapartum cesarean section. Among the tallest quartile of women, about 10% of those with babies in the smallest head circumference quartile had a cesarean section versus about 30% for those whose infants were in the largest head circumference quartile. Thus, within the lowest and highest height strata, women with babies having the largest head circumferences were more than twice as likely to need cesarean section as those with babies having the smallest head circumferences. The association between cesarean section rate and fetal head size was also present in the three intermediate maternal height strata.

Studies on nutritionally at-risk white and Asian women in England and Indonesia showed that protein-energy supplementation during pregnancy did not significantly affect birth weight and length (Watney et al 1986; Kusin et al1992). Kramer (1993) also concluded that prenatal protein and energy supplementation offer little benefit to either the mother or infant. Other studies, however, have shown that protein-energy supplementation of pregnant women, at risk of delivering a LBW infant, enhanced intrauterine growth (Prentice et al 1980; Herrera et al 1980; Brown 1983; Ceesay et al 1997; Winkvist et al 1998). Prentice (1991) reviewed food supplementation programs targeted to pregnant women and concluded that supplementation during late pregnancy can have a significant beneficial effect on birth weight in women who are genuinely at risk as a result of an inadequate diet. The effect will depend most likely on the nutritional status of the women, which is multifactorial, and few good intervention studies have been conducted. Efforts to reverse intrauterine growth restriction have been disappointing and at times risky (Strauss 1997). Nevertheless, Strauss (1997) agrees with Prentice (1991) that energy supplementation in undernourished populations may be of significant benefit. Winkvist et al (1994, 1998) make an important distinction in terms of maternal and fetal weight gains due to supplementation. They suggest that supplementation of moderately malnourished women tends to increase birth weight while having little effect on maternal weight, because the extra energy goes to the fetus. In contrast, severely malnourished women may not be able to divert this energy to the fetus; thus, supplementation has a greater effect on maternal weight gain and less on birth weight.

Garner et al (1992) suggested that interventions to increase birth weight could be hazardous to women because they could lead to more mechanical difficulties in labor where access to the proper care might not be available. Few data are available to support this hypothesis. Prenatal supplementation (60 mg iron, 250 g folate, with or without 15 mg zinc) in Peru produced no effect on birth weight or head circumference (Caulfield 1999). Goldenberg et al (1995), however, found that daily supplementation with 25 mg zinc in early pregnancy for women with relatively low plasma zinc concentrations was associated with significantly greater infant birth weights (126 g) and head circumferences (0.4 cm). This effect was greater in women with a body mass index (Kg/m^2) < 26, where birth weight was significantly higher (248 gm) and head circumference significantly larger (0.7 cm). Among the zinc supplemented group, about 50% of the effect was due to a longer gestational age and a similar percentage was due to improved fetal growth. Ceesay et al (53) found a small (3.1 mm) but statistically significant increase in head circumference with daily high-energy supplementation, which translated into an increase of only 1.5 mm in diameter, which is unlikely to increase the prevalence of cephalopelvic disproportion.

Konje (in press) notes that despite the absence of any negative effect of supplementation on obstructed labor, the situation may be different for women who's skeletal – and, therefore, pelvic – growth was restricted during childhood and early adolescence but whose general food intake increased later on. Abitbol et al (1997) stated that mothers born and raised outside the United States (with narrow pelvic dimensions) who ate a high-protein diet and received adequate prenatal care after migrating as adults to the United States gave birth to relatively large infants. This resulted in a marked cephalopelvic disproportion and severe dystocia, which frequently led to cesarean birth. Observations from the United Kingdom (Konje, in press) show that feto-maternal disproportion is more common in first-generation than in second-generation minority groups. These effects are more marked in women who are shorter and by inference more growth retarded.

A WHO (1999) review of interventions for physical growth and psychological development concluded that supplementary feeding of pregnant women had a strong and consistent positive effect on motor development of infants. Other intergenerational issues have also been studied. Ramakrishnam et al (1999) examined the effects on growth using data from 14 studies among middle-class populations in developed countries. Maternal births were generally from the 1950-60s and that of their children's the 1970-1980s. Height and prepregnant weight ranged from 162-168 cm and 55-62 Kg, respectively. Overall, for every 100 g increase in maternal birth weight, the birth weight of their infant increased by 10-20 g. Among the very few studies that looked at the association between adult heights of parents and their offspring, correlation coefficients were between 0.42-0.5. More specifically, in a prospective analysis of data from Guatemala, Ramakrishnam et al found that child birth weight increased by 29 g for every 100 g increase in maternal birth weight, which was almost double that reported for the developed countries. Child birth weight increased by 53 g/1 cm increase in maternal birth length, but this was reduced to 38 g/cm after controlling for maternal height and prepregnancy weight, which the authors suggested was due to the intergenerational effects of maternal birth size. Child birth length also increased, by 0.2 cm/1 cm increase in mother's birth length and by 0.1 cm/100 g increase in maternal birth weight, although the former was no longer significant after controlling for adult size.

Two hypotheses related to the non genetic transmission of an intergeneration effect on birth weight come from Emanuel (1993) and Barker (1994). Emanuel postulates that IUGR is associated with lower organ weight due to less cytoplasm per cell rather than fewer cells. Barker proposes the fetal origin's hypothesis to explain in utero. This, a consequence of maternal nutrition status (maternal environment), leads to fetal adaptations that permanently alter the physiology and metabolism of the body leading to chronic disease in adult life. Barker's hypothesis, however, is based on epidemiological evidence of associations and a causal effect cannot be implied.

Secular studies of birth weight have shown an increase across generations with no adverse effects reported (Alberman 1991), which Konje (in press) suggests is because other secular changes in maternal proportions are also occurring and this increase in fetal size does not create cephalopelvic disproportion. Li et al (1990) found that mean birth weights of infants born to southeast Asian parents who were born outside the United States increased annually by about 18 g (95% confidence interval: 11, 25 g) between 1908–1981 and 1986. A similar secular change of birth weight during the same period of time was not observed for infants of US-born Asian mothers. This, the authors suggest, shows migration from their native countries to the United States had a positive effect on the birth weight of infants born to these mothers. Secular changes in birth weight were also observed in Asians living in England (Clarson 1982). Infants of migrant Pakistanis were 139 g heavier and those of migrant Indians 25 g heavier in 1978 than they had been 10 y earlier, reinforcing the concept that environmental factors play an important role in intrauterine growth.

Lactation

The demand for both energy and many nutrients is also increased during lactation, although it is assumed that a well-nourished lactating woman will draw on fat stores laid down in pregnancy. An undernourished women, with little fat storage, will require extra energy equivalent to an additional meal/day (LINKAGES 1999). Except under extreme famine-like conditions, undernourished women produce sufficient breast milk, but its nutrient quality can vary depending on the status of the mother (Allen 1994b). Also, severely undernourished women do not have adequate capacity to sustain prolonged lactation (Adair 1987; Lechtig and Shrimpton 1997), which has implications for the infant.

While lactation is important for the infant, it can also have adverse effects on a mother who is not at her nutritional optimum. Adair and Popkin (1992), for example, found that lactation has a significant negative effect on weight among urban Filipino women, which increased with the intensity and duration of breast-feeding. They concluded that the effects of prolonged breast-feeding (beyond 12 months) needs to be mitigated by increased dietary energy intake.

The WHO (1999) review of interventions for physical growth and psychological development also concluded that supplementary feeding of lactating women has a strong and consistent positive effect on motor development of infants, and this effect is more evident after the age of 18 months than before. As the authors point out, however, many characteristics of both breastfed and non breastfed babies and their mothers differ, making it difficult to identify the mechanisms for the associations.

Clinical signs of vitamin A deficiency are known to exist in lactating women (IVACG 1997) and postpartum supplementation, within 6-8 weeks of giving birth, has been shown to be beneficial and safe for both the mother and new born baby .

Post reproductive age (49+)

Older people in developing countries often contribute to household food security by participating in agricultural tasks and small business. They also contribute by nurturing grandchildren and other young relatives. In the wake of HIV/AIDS, the role of older people is changing; younger adults succumb to this disease more, leaving behind young children who must be cared for by older people who, thus, need to remain independent and economically active (S. Ismail, personal communication 1999).

Undernutrition (BMI < 18.5 Kg/m^2) caries a measurable disadvantage in terms of an older person’s ability to lead an independent life and has been shown to be a significant problem in the elderly (Chilima 1998; Manandhar 1999; Pieterse 1999). In all of the above studies, poor nutritional status was associated with poor functional ability, measured by handgrip strength, as well as mobility. Older people are also known to be at greater risk of cardiovascular disease, diabetes, and osteoporosis.

5. INTERVENTIONS TO IMPROVE NUTRITIONAL STATUS THOUGHOUT THE LIFE CYCLE

Although primary health care nutrition programs are often targeted to women, particularly pregnant women, in practice the majority are primarily designed to reduce malnutrition in children. Leslie (1991) makes an important distinction between being the target and being the beneficiary of a program; indeed, women have been the targets of nutrition and health programs aimed at improving fetal growth (birth weight) and/or children's growth with little attention to their own health and nutrition needs. At the program level, there is currently a move toward getting a consensus that health and nutrition programs implemented well before women become pregnant, and within a life cycle perspective, will have a long term impact on both the mother and child, although program-level data to support this are still lacking. It is also quite probable that women will be more likely to be motivated to participate in program activities that have a clear benefit for themselves as well as for their children. Thus, strategies to improve the nutrition of girls and women of reproductive age need to go beyond the conventional approach of providing services to pregnant women though the traditional maternal and child health care programs. This means that greater effort needs to be placed on nutrition-related behavior change that can be integrated with other programs, be they health-based or not.

For socio-cultural reasons nutrition interventions, targeted to women or other groups, are expected to be equally or more strongly influenced by policies and actions intended to improve nutrition in the entire household, e.g., increased crop yields, higher income, food price subsidies, better nutrition knowledge, and/or food fortification, than those targeted solely to women. The focus of this paper is on effective community- and household-level programs that can target females directly or indirectly as part of the life cycle continuum, and which USAID can support through its existing portfolios. This means that the provision of regular health/nutrition services for females require that a comprehensive program is provided, rather than single isolated or vertical programs. Although framed in the context of a life cycle approach, program focuses can be incorporated into existing targeted interventions: child survival (infancy and early childhood or below 24 mo), early child development and primary school (childhood or 2-9 yrs old), secondary school (adolescents or 10-19 yrs old), adult women of reproductive age (20-49 yrs old), pregnant women and lactating women, and post reproductive age women (49+ yrs) (Table 3). A critical aspect is that appropriate information, education, and communication aimed at key behavior modifications for that life period are not only given but put in the context of future welfare.

Infancy and early childhood (<24 months)
Interventions targeted to this age group fall under the well-established rubric of child survival programsm, which USAID supports in many countries. They include appropriate infant and child feeding, full immunization, control of diarrheal disease, vitamin A supplementation, and management of the sick child. Caulfield et al (1999) recently completed a comprehensive

evaluation of the extent to which research and programmatic efforts over the last 2 decades have been able to improve dietary intakes of infants 6-12 months old. They were able to identify 5 efficacy trials and 15 programs. The efficacy studies showed that increasing complementary food intake reduced undernutrition in late infancy. The programs reviewed included trials of new feeding practices, foods, and recipes. Several common barriers to using the new foods were identified including the need for the child to like the new foods, the ingredient-foods have to be affordable, the time need to for their preparation and/or to feed them must involve minimal changes in maternal time, and mothers would discontinue giving the food if the infant became sick or had another negative reaction attributed to the food. Despite these barriers, the trial results provided plausible, not causal, evidence that a comprehensive multifaceted approach, which included both breastfeeding promotion and complementary feeding, could identify affordable and acceptable means for care takers to improve infant feeding, improve care taker knowledge and beliefs about optimal infant feeding, improve infant feeding practices, increase total energy intake, and improve the growth rates (wt/age and ht/age) of older infants. In the 15 program studies increasing energy intakes by 70-165 kcal/d resulted in an improved growth of –0.08 to 0.87 SD. The authors determined that the average positive effect on growth from the 20 studies was about 0.2-0.3 SD and calculated that this increase in the average Z score would decrease the prevalence of undernutrition by 3-12%, and might reduce the proportion of deaths attributable to undernutrition by 4-8%, depending on the underlying prevalence of malnutrition in the population, and assuming a normal Z-score distribution post intervention. The above shows that identifying and dealing with community-based barriers to changing feeding behavior can result in nutrition education programs having effective behavior changes to improve infant and young child growth (and thus survival). Other interventions to improve the nutrition of infants and young children, for which accepted indicators exist, are prolonged breastfeeding and feeding during diarrheal disease.

Vitamin A supplementations programs are in place in many countries and, increasingly, supplements are distributed through national immunization where the focus of often on polio immunization. This is a good short term opportunity, but action is needed to strengthen distribution through the routine health system, otherwise coverage will fall once the polio eradication campaigns cease.

Currently, little if anything is being done to control anemia in infants and young children. Greater emphasis needs to be put on *appropriate* and *relevant* food based approaches. The use of new technologies, such as microencapsulated sprinkles, warrants further exploration and promoting the use of fortified complementary foods needs to be expanded. With the advent of the roll-back malaria program, promotion of the use of insecticide impregnated bed nets for young children to control malaria vector transmission is being encouraged. Demonstrating this program has an impact on anemia would help to promulgate anemia control.

Women are increasingly working outside the home to supplement family incomes or pursue careers, but few have access to high quality child care (S. Ismail, personal communication 1999). Little is known about the influence of existing (traditional or modern) child care strategies in child nutrition and development, including any gender biases in child care and why they may occur, which is important for planning, implementing, and evaluating programs and in educating mothers about the benefits and limitations of each method. Work is needed in this area as well as how these strategies fit in with the nutrition-related child survival interventions.

Childhood (2-9 years)
The WHO (1999) review on interventions for early childhood (up to 6 years old) physical growth and psychological development identified and reviewed 7 programs that combined both feeding and mental stimulation interventions. The report noted that it is not always possible to separate out the effects of nutritional and psychosocial interventions on physical growth and psychological development. Care giving was positively influenced by the interventions, and 6 of the 7 programs reported significant effects on different measures of psychological development while 2 reported clear effects on growth and 2 reported likely effects on growth. Five of the studies, however, enrolled children over 3 years old and it is unlikely that nutritional inputs would have had an effect on growth in these children. Moreover, not all the children were at risk of undernutrition and some of the programs were primarily focused on early childhood stimulation. The authors concluded that combining the two interventions would have a greater effect than either alone in populations at risk of and poverty. The report also noted that unless behavior change programs deal with participants' perceived needs, and include concerns that can motivate people to take action, the programs are unlikely to be successful. This is because parents are generally very interested in promoting the psychological development of their children, especially where school success gains importance. In contrast, chronic undernutrition is often not recognized, partly because the norms for child size are far below those for well-nourished populations. The authors cited 3 studies focused on preschool children, which showed caregivers maybe more motivated to participate in combined programs that provide information and activities related to child psychological development, i.e. the positive deviance and HEARTH model approach. This suggests that these approaches warrant further exploration and evaluation.

Between 1990 and 1995 alone, the number of children enrolled in primary school in developing countries has jumped by some 50 million. Research has also shown that the single most important factor in determining a child's health and nutritional status is its mother's level of education; thus, educating mothers-to-be is one of the best ways of ensuring the nutritional future of the next generation (WHO 1998). Nutrition education can have a significant effect in promoting healthy eating habits, and schools can contribute to reducing nutrition-related problems by integrating nutrition interventions into a comprehensive school health program The social roles of girls (and women) can also be enhanced through nutrition interventions (WHO 1998). For example, increasing the nutritional knowledge of girls from an early age can help to ensure better preparation, preservation, handling, and intra-household distribution of foods. Increasing their capacity to handle their responsibilities can, in turn, enhance the social and economic status of girls and women. For this reason, ensuring schooling with effective nutrition interventions for young children can be one of the most important and effective means of improving women's nutrition and health status because of the associated effects on health, fertility, and social development.

Increasingly, early childhood learning centers (ELC) are being put in place with World Bank support. Together with primary schools, it is possible to intervene to reach children 2-9 years old and often older children who are still in primary school. Research shows that school feeding programs improve school attendance and reduce both drop out rates and repeating years (miller del Rosso 1999). Whether the meals provided substitute for other meals is not clear. In several countries, including Guinea, Malawi, Madagascar, Zambia and Senegal, World Bank funded programs have trained teachers to deliver iron and iodine supplements and drugs for worms and bilharzias. Currently, USAID supports large school-based health programs that deliver health interventions, such as deworming and vitamin A supplementation across Africa, which are in various stages of evaluation. A similar strategy is being developed for Latin America. USAID also supports smaller school health activities such as latrine construction, community based nutrition grants, school gardens, and borehole drilling within USAID and UNICEF sponsored programs in Africa. Besides deworming and vitamin A supplementation, nutrition and health education to change health practices are carried out in primary schools. In Ethiopia, for example, USAID's Basic Education System Overhaul program worked with its local Child Survival program to integrate key community health messages into the new elementary school curriculum. The two USAID programs also coordinated their community mobilization activities so that school and health topics are integrated at every opportunity.

In Zambia, USAID/Zambia sponsors several aspects of education systems reform within the sector investment program, including the school health component. The USAID school health intervention will pilot deworming and micronutrient delivery to improve student nutrition and reduce iron deficient anemia. It also intends to document the benefits for improvement of cognitive capacity and learning outcomes. Recently, USAID/Zambia began supporting a child-to-child-to-parent campaign for malaria prevention in five basic and three primary schools as part of its integrated malaria initiative. At the moment the focus is on malaria prevention, but there could be scope to expand this to include anemia control.

Where institutional feeding is provided, the potential exists to provide fortified food be it in a meal or as a snack food. In Haiti, for example, CRS support an expanded school-feeding program in 450 primary schools. School canteens provide 1,000 kcal/d per child in a mid-morning meal. This aims to increase attention span, through the alleviation of short-term hunger, and to help increase school retention rates. The program also includes quarterly distribution of vitamin A; a six monthly anthelminthic; and extra-curricula health education activities.

In situations where institutional feeding is not provided in primary schools, for example, in Uganda, community mobilization activities of the USAID-sponsored primary education reform incorporated messages to support student health and nutrition. One result of community education efforts has been that children in many parts of Uganda now take food for a mid-day meal to school. Prior to the mobilization most children in Uganda did not eat during the school day.

Because not all children go to school, child-to-child nutrition-related activities need to be explored further and tested. This may be particularly relevant for girls in situations where many girls do not go to school, such as in India.

Adolescents (10-19 years)
Few intervention studies have been done on adolescent girls, and those that have focused on anemia prevention. A clinical trial assessing the effects of iron deficiency on cognitive function in the USA found that iron supplemented adolescent girls performed better on a test of verbal learning and memory than the control group (Bruner et al 1996). In India, 1 year after implementing a 6 months communication strategy to improve dietary intake and reduce anemia and undernutrition in early adolescent school girls, growth velocity, mean hemoglobin levels, anemia-related knowledge, and dietary behavior improved significantly in the experimental compared with the control group (Kanani and Agarwal 1997). Operations research has shown that well-supervised intermittent iron supplementation to adolescent girls in schools or workplace can reduce their prevalence of anemia (Beaton and McCabe 1999). While iron supplements have been shown to be important for correcting iron deficiency anemia in adolescent girls, Lynch (in press) has shown that there is only a modest improvement in storage iron status in early pregnancy following supplementation in adolescence, if the time between the end of supplementation and conception is more than a few months. In other words supplementation in adolescence cannot build sufficient stores to substitute for the need for iron supplements in pregnancy. This is because iron absorption is closely regulated in the body and the body limits the size of the stores.

Another study in India showed that daily, but not weekly, iron supplementation for 12 weeks improved the appetite of adolescent girls, and there was a significant increase in mean weight and maintenance of BMI in the intervention group compared with the control group (Kanani et al 1998). These responses, however, were seen in both the anemic and non anemic children in the intervention group, which the authors suggested could have been due to the increased energy expenditure of the anemic girls offsetting the benefits of the improved food intake due to improved appetite. There was also no difference in BMI between the anemics and non anemic girls in either the intervention or control groups.

Secondary schools are the easiest way to reach adolescents, although in many countries relatively few girls go to school compared with boys. To be effective, however, any credible intervention program will have to reach the girls who do not attend school. Currently, the few activities targeted to this age group center around HIV/AIDS awareness and education, including the prevention and management of STDs. Increased attention is being given to the need to provide this age group with life-cycle nutrition and health education. Already basic nutrition is taught as part of life-skills training in some schools. Currently, USAID supports such training in several African vocational training programs, including Zambia and South Africa, although only reproductive health and HIV education are emphasized.

As with primary schools, there is scope to expand deworming and micronutrient supplementation within educational settings, be they schools or vocational training activities. Supplementary food can also be provided through school meals to induce growth and maximize the pubertal growth spurt; increase school attendance; and serve as an excellent opportunity for nutrition and health education relevant to the age group. Such interventions are likely to be effective because of the potential for good supervision.

In contrast to the above, there are few opportunities to contact adolescent children who do not go to school. These children, especially the girls, are particularly vulnerable and often have no voice in the community. Various NGOs and projects such as FOCUS have been exploring ways to reach these adolescents, including the socially marginalized, through community youth groups, the workplace, religious organization, etc, and the potential exists to include nutrition and health promotion in addition to education about HIV and STD prevention. The nutrition-related activities, however, need to be based on qualitative research that has identified cultural and institutional constraints to good nutrition and detrimental attitudes and practices toward food and eating behavior. With creative thinking, nutrition and health-related activities can be incorporated into group activities, but they need to be perceived to be relevant to their lifestyles rather than imposed. Any interventions for adolescents, however, will require sensitizing communities to the health and nutritional needs of adolescents, gaining community and parental support for action, as well as identifying the perceived needs of the girls themselves.

Women of reproductive age (20-49 years)
Most health and nutrition education activities currently targeted to women focus almost exclusively on child feeding, particularly breast-feeding. There is a need to redirect some of the behavior change focuses to women themselves. Concrete efforts are needed to improve women's eating practices, which is important for both their own health as well as that of their child(ren), particularly in rural areas where women endure the dual burden of moderate-to-high levels of physical work and frequent pregnancies, without noticeable increases in energy and nutrient intakes. This would include specifically designed behavior change activities targeted to women to reduce and ultimately remove any self-sacrificing attitudes that limit their access to and intake of food.

Many programs designed to improve food security include adult women of reproductive age, who may not be pregnant or lactating. Managers of these programs recognize that the nutritional benefits are not necessarily direct, and it is not easy to measure or attribute any change in nutritional status to the intervention. Such projects, which invariably strive to empower women, include income generation or credit schemes, home gardening and agriculture, improved technologies, and adult literacy alone or combined with each other. The extent to which these programs have been successful in improving nutrition is beyond the scope of this paper. Suffice to say that there is often a nutrition component to the program that focuses on child feeding and the outcomes measured are infant feeding patterns and/or the nutritional status of the young children. Given that food security projects are targeted to households, behavior change activities need to be comprehensive and lifecycle focused rather than targeted only to infants and young children or pregnant women. Moreover, because the nutritional benefits to these programs are not direct, it is logical to assume that a measurable nutritional outcome is not always likely – at least in the short to medium term. For this reason, measuring the extent to which behavior changes are taking place becomes important and much more work is needed in this area.

Health-based interventions such as family planning and longer birth spacing are assumed to have a more direct effect on women's nutritional status but the inputs and outcomes rarely, if ever, include issues related to improving the nutritional status of the woman. The potential, however, is there to change this. Nutrition could also be better integrated with the prevention and management of reproductive tract infections and STDs because reduced infection rates are likely to improve nutritional status. The role of iron/folate supplements remains equivocal, except where severe deficiency exists, and insufficient data are available to justify the provision of free multiple micronutrient supplements through the public health system. Nevertheless, an important issue is the effective delivery of supplements, which can also be done through the private sector, especially to women before they become pregnant so that they would be in the best nutritional state possible, which may be related to 'knowledge management' of both women and health care providers. Unless both the supply and the demand side issues for supplementation are addressed concurrently, it is unlikely that these programs can be successful.

In urban areas, adult women of reproductive age can be reached through the workplace, social/community groups, religious centers, etc, where the possibility exists to get institutional support for health related activities that include nutrition. Similar groups could be used in rural areas where they exist and activities that support or strengthening group 'cohesion' should be seen as a component of an add-on nutrition/health activity. As with the other groups of the life cycle framework, it would be important to put nutrition in the context of perceived priorities.

Pregnancy
Prenatal programs focus on identifying and counseling pregnant women on appropriate care and nutrition, including breast-feeding, tetanus toxoid immunization, iron-folate supplementation, and referral of high risk pregnancies. Malaria chemoprophylaxis, especially among primigravidae, and deworming need to be encouraged in areas where these parasites are public health problems. Much of the program emphasis to date is on getting women to come for services rather than the quality of care provided and a lot more work is needed in this area, including prompt diagnosis and treatment of illness. Some programs provide and target supplementary food to at-risk and undernourished women and efforts are needed to identify these women and begin supplementation as early as possible during pregnancy.

Most prenatal programs also include delivery care, which focuses on the provision and appropriate use of safe birth kits and procedures, referring birth complications, and appropriate counseling on neonatal and infant care. The provision of post-partum vitamin A supplementation is increasing and this needs to be further expanded.

There is little documentation on program experiences to improve nutrition, food intake, and weight gain during pregnancy in developing countries. Despite the research evidence that iron supplementation is efficacious, this relatively simple program has not been effective in reducing the prevalence of anemia among women (Galloway and McGuire 1994; Yip 1996). Most iron/folate supplement programs for pregnant women suffer from serious operational constraints related to supply and distribution systems, access to health care services, motivation and behavior of health care providers, and compliance by the target population. Unresolved problems that affect supplement acceptability as well as compliance continue to persist and include the lack of good quality, low cost, generic supplements; suitable compounds and dispensing mechanisms; and potential side effects (real or overestimated). These operational constraints could possibly be overcome, if the institutional and operational constraints were identified[14].

Although there is little evidence that an iron supplement program works, it remains one of the few options available to improve iron status of the population and it is the only program that has the potential to meet the high iron requirements during pregnancy (Viteri 1994). Operations research has shown that intermittent supplementation is not appropriate for pregnant women and daily iron supplementation must be continued as the intervention of choice (Beaton and McCabe 1999).

Lactation

Postnatal programs cover lactation. These include counseling on nutrition (including breast-feeding) and family planning, although these two programs are not usually integrated. Promotion of positive health and nutrition practices for females of all ages needs to be expanded, including behavioral changes to improve maternal, infant, and early childhood feeding.

Where the prevalence of anemia is over 40%, iron/folate supplementation should be extended through the first 3 months of lactation.

Post reproductive age (49+)

There are no reports on nutrition interventions for older people, successful or otherwise (S. Ismail, personal communication 1999). At best, they are covered in food security projects targeted at the household-level, although the focus is generally on maternal and child nutrition. Work is needed to determine the role of older women as child care takers and as indirect and direct providers of food for the household; the effectiveness of dietary change and nutrition education as a means to improving the nutritional status of older people and how this affects their role as child care takers; and to determine the way to improve their nutritional status within the existing household resources.

Whether interventions designed to improve the nutritional status of older people, including income generating activities, can also improve functional ability and thus their quality of life is unknown. Limited evidence exists to show the effect of nutritional support in communities in developed countries on the elderly. Such support in hospitals and institutions has been associated with reduced hospital stay, reduced rates of complications, and improved quality of life (S. Ismail, personal communication 1999).

6. POLICY OPTIONS

In the ideal world, policy and program options are based on an empirically-based conceptual framework. Unfortunately, this has rarely been the case for women's nutrition in developing countries. There is an urgent need to identify the conditions and circumstances under which , i.e.,

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[14] USAID's MOST project has developed tools for conducting a situation analysis for the supply and demand for micronutrients at the institutional and community level.

energy and protein or specific micronutrient deficiencies, can be prevented throughout a woman's life cycle, after which the appropriate policies can be carefully shaped to the particular situation in each country or setting. Advocating that women's nutrition is important per se must be the starting point.

The text that follows identifies some general and specific policy options that have either been effective or are likely to be effective, although there may be no data to support the latter.

Policy
At the policy level several initiatives have been proposed (adapted from Tinker et al 1994). Those listed below are the ones considered most feasible, although not all are proven.

Infancy and early childhood
- Integrate MCH and nutrition services, including family planning and HIV/STD education
- Fortify commercial complementary foods with vitamin A, iron, iodine, and any other required micronutrients where technically feasible
- Disaggregate child survival and other health data by gender to identify and take corrective action against gender discrimination, where it exists

Childhood
- Provide regular deworming and micronutrient supplements through local institutions, e.g., schools, other training institutions, churches, and other community-based groups
- Integrate age-based appropriate nutrition behavior change programs through existing education and community-based programs
- Disaggregate data on the provision and outcomes of health, nutrition, and school interventions by gender

Adolescence
- Provide regular deworming and micronutrient supplements through local institutions, e.g., schools, other training institutions, churches, and other community-based groups
- Determine social, health, and nutrition needs of adolescents
- Improve access to reproductive health services including information about nutrition, health, STDs, and family planning
- Expand opportunities to reach adolescents and deliver nutrition and health services including education through schools and other community based initiatives targeted to adolescents
- Disaggregate data on service provision by gender

Women of reproductive age
- Promote intersectoral coordination on nutrition, e.g., with labor, education, agriculture, supply/commerce
- Provide reproductive health services that includes a nutrition-based behavior change component to all women irrespective of age, marital status, etc,
- Improve access to reproductive health care services

- Establish and monitor child care and development centers
- Implement system to monitor quality of care, including nutrition counseling and education provided in health services
- Fortify commonly eaten foods with vitamin A, iron, and iodine
- Improve logistics of drug supplies

Pregnant and lactating women
- Improve the quality of antenatal and postnatal care services
- Implement system to monitor quality of care
- Implement parasite control (malaria and helminth) program in endemic areas

Post reproductive years
- Expand surveillance data gathering to document the role of older women in child care and the health and needs of older women
- Include the elderly in food security programs

7. INDICATORS

Indicators of risk have generally been assumed to predict response to interventions, but this is not always the case (Ruel et al 1996). This section discusses indicators that measure or have the potential to measure programmatic effect, although not all have been validated. Indicators that are useful for screening or identifying at-risk populations are not discussed. For the anthropometric indices, the relevant WHO recommended reference standards should be used. Biological markers are preferable to coverage as measures of program effectiveness. Nevertheless, they are invasive and their use is often limited by cost, level of skill required, and time.

Infancy and early childhood: The indicators for measuring the effectiveness of interventions to improve child feeding, micronutrient supplementation, and managed morbidity are established and shown in the third column of table 3 for the respective interventions. More emphasis, however, needs to be placed on disaggregating the data by gender.

Childhood: Determining the effect of early childhood development and primary school programs on the nutritional status in children can be done by measuring coverage for micronutrient supplements, anthelminthics, bednet use, and meals eaten at school. In addition, biological markers for vitamin A, anemia, helminth intensities, and height-for-age can also be used. Measurements of cognition are difficult to develop and standardize; thus, proxy measures for school attendance, drop out, and repeaters can be used (Miller del Rosso 1999). Because child survival programs focus on the under 5 year olds, the indicator covers both children 2-5 years olds and 6-9 year olds who are often in primary school. Again, gender-specific data represent important measures for assessing program impact particularly where programs are intended to address gender issues.

Adolescence: As with the younger children, both coverage and biological indicators can be used to show programmatic effects for deworming, iron supplementation, and school meals. In terms of program effect on growth, WHO (1995) recommends the anthropometric indicators height-for-age or BMI-for-age be used for adolescents. The cutoff point for stunting is <-2 Z scores. BMI has not been fully validated as an indicator of thinness in adolescence and little is known about specific levels of BMI in adolescence and its response to interventions. Nevertheless, a BMI-for-age <5th percentile is generally used as the cutoff for those most in need of intervention. In program settings, intervals of 6 months and 3 months are sufficiently long to allow significant height and BMI increments, respectively, to be detected throughout most of adolescence. Programmatic effects can be measured as mean changes in Z scores for height-for-age and mean and standard deviation BMI and change in prevalence of height-for-age <-2 Z scores or BMI-for-age <5th percentile. Where the BMI-for-age is well below the 5th percentile of the recommended reference data, it may be necessary to develop local cutoffs or reference data to measure program effects.

The indicators to use for measuring the effect of behavior change interventions that can be given through nutrition and health education at schools or through STD/HIV prevention programs will depend on the messages being given. It is unlikely that the messages will result in a biological outcome; thus, developing indicators to capture stages of behavior change is an important area warranting further work.

Adult women of reproductive age: For non pregnant non lactating adults in populations where undernutrition is widespread, BMI is the indicator of choice. However, BMI reflects variation in lean body mass (rather than level of adiposity) and all its correlates including iron status, energy and protein reserves, physical activity, and so forth. Nevertheless, mean adult BMI and BMI distributions can be used to assess the effect of interventions. WHO (1995) suggests the flowing classification of a public health problem of low BMI, although the cutoffs are somewhat arbitrary:
Low prevalence: 5-9% of population with BMI <18.5
Medium prevalence: 10-19% of population with BMI <18.5
High prevalence: 20-39% of population with BMI <18.5
Very high prevalence: ≥ of population with BMI <18.5

Chronic Energy Deficiency (CED), which is associated with increased risk of ill-health, poor physical performance, lethargy and even death, has also been defined. However, further work is needed to validate the cutoffs used against functional outcomes that control for immunocompetence and micronutrient deficiencies. The current definitions are:
Grade 1: BMI 17.0-18.49 (mild thinness)
Grade 2: BMI 16.0-16.99 (moderate thinness)
Grade 3: BMI <16.0 (severe thinness).

The indicators to use for measuring the effect of behavior change interventions that can be given through nutrition and health education food security and reproductive health programs will depend on the messages being given. It is unlikely that the messages will result in a biological outcome; thus, developing indicators to capture stages of behavior change is an important area warranting further work.

Pregnant women: Anthropometric measurements during pregnancy are often used to evaluate interventions to improve fetal growth or prolong gestation. Nutritionally-related IUGR can be the consequence of both low availability of nutrients from an undernourished mother and poor placental transfer of nutrients from a relatively well nourished mother. Maternal anthropometry will not detect the latter problem. The association between maternal nutrition status and gestational age at birth is not clear, as it is not necessarily independent of intrauterine growth retardation, and maternal nutrition is only one of the underlying factors (WHO 1995). The IOM (1997) states that there is a lack of consistent findings regarding the association between birth prepregnancy weight, body mass index, and height, among other things, and maternal weight or weight gain in pregnancy. Unequivocal changes in maternal weight gain are seen only in women near starvation and to a lesser extent the clinically undernourished; thus, the use of weight gain to evaluate the effect of interventions to improve maternal weight requires further work. Despite this caveat, WHO (1995) recommends weight and gestational age be measured to determine the rate of weight gain to assess the response to an intervention during pregnancy. The specific indicators are Kg/week over at least a 4-week period; prevalence of weight gain below a cut off; or mean weight gain. These measurements should be done during weeks 20-32 of gestation or in the second and third trimesters of pregnancy. The WHO Collaborative Study (1995) showed that weight gains of 1.5 Kg/month during the last 2 trimesters are consistent with good pregnancy outcomes in developing countries.

The effectiveness of malaria, deworming, and post partum vitamin A supplementation programs can be shown with both coverage data. Coverage data can also be used for iron/folate supplementation program, with Hb concentration as the biological marker.

Lactating women: There are no good anthropometric indicators to measure a program's effect on lactating women and further work is needed in this area. Weight loss during lactation is much greater in the first month because of the loss of extra water, tissue, and to some extent the fat gained during pregnancy. There is evidence that poor postpartum nutritional status, measured as a low BMI, is associated with poor lactation performance and poor infant growth suggesting that BMI maybe a good indicator of postpartum nutritional status. WHO (1995) state that it is possible to estimate a level based on the lower limit of BMI (<18.5) adjusted for the average weight (4 Kg) retained by mothers following an acceptable pregnancy weight gain and enough time for postpartum hydration to have equilibrated (2-4 weeks). This gives an estimated cutoff of BMI of 20.3 at 1 month postpartum for women 150 cm tall. BMI can be expected to fall during the first 6 months of lactation, after which the usual cutoff to define chronic energy deficiency (BMI <18.5) can be used.

Where iron supplementation continues through early lactation, coverage data and Hb concentrations can be used to measure programmatic effect.

Post-reproductive age: Measuring nutritional status in the elderly is fraught with problems (Manandhar 1999). Measurements such as BMI that use height can be misleading due to kyphosis. Even by the age of 50-54 years, age-related vertebral changes can have occurred. Also, body composition changes with age and underweight may not be present at a low BMI. Currently BMI cutoff of 18.5 and 16.0 are used to define thinness and severe thinness. Other indicators that have been studied include mid-upper-arm-circumference and calf circumference, but these too have limitations and the cutoff points used vary. Similarly, having a standardized measure of functional ability is problematical due to cultural differences in what is considered appropriate, the assessment sequence, motivational issues, and non-familiarity of what is required for the test. There is an urgent need for further work in this area.

8. PROSPECTS AND CHALLENGES

The prospects to improve maternal nutrition are contingent upon there being political commitment as well as national capacity to develop and implement sound policies and programs. Policy decisions and program implementation will be affected by the context of nutritionally relevant global trends that are characterized, on the positive side, by increased women's education, delayed age of marriage, declining fertility rates, smaller families, longer life expectancy, greater health system coverage, and increased women's participation in the labor force and, on the negative side, by severe resource constraints, slow economic growth, poor use of available health and nutrition services by females, and slow progress to improving the social status of women in many countries.

The challenges ahead are not insignificant. Regrettably, conceptual and implementation constraints have minimized the impact of efforts to improve women's nutrition largely because the focus has been almost exclusively on the prenatal period (Baker et al 1996). Many programs have been conducted as small-scale research activities or vertical interventions, or they have relied heavily on manipulating only the biological factors that influence women's nutrition. The above approaches are difficult to scale up because of the lack of broad-based support and demand for the services. Although, as emphasized earlier, efforts to improve women's nutrition in a sustainable way must adopt a life cycle perspective, the reality in most developing countries is that financial and resource constraints often reduce action to a few programs that tend to focus on pregnancy and to a lesser extent lactation. Integrating programs across and within sectors can help to maximize resources. To do this, however, a stronger political commitment is needed to support women's health and nutrition and to create the demand for at least a minimum package of services.

Women's nutrition remains a global issue with common problems and constraints that will only be resolved if women's health and nutrition are put in the context of the life cycle rather than in discrete compartments. This includes addressing the underlying sociocultural determinants of behaviors connected to women's nutrition at all stages of the life cycle.

Table 1. Selected maternal and nutrition-related indicators by region, 1998					
Region	Total women[1]	Women 15-49 yrs[1]	Maternal mortality[1]	Anemia prevalence (%)	
	million	million	/100,000 live births	Pregnant	Non pregnant
ASIA	1753	929	410	60[2]	55[2]
Western	88	44	350	na	na
South Central	701	354	570	na	na
Southeast	253	135	460	na	na
East	711	396	90	na	na
AFRICA	390	182	880	51[2]	42[2]
sub-Saharan	321	146	980	na	na
Northern	83	42	330	na	na
Western	115	100	1020	na	na
Eastern	121	108	1080	na	na
Middle	46	41	950	na	na
Southern	25	20	270	na	na
LATIN AMERICA & CARIBBEAN	252	134	180	35[3]	20[3]
Central	66	34	140	na	na
Caribbean	18	10	350	na	na
South	167	90	190	na	na
WORLD	2941	1514	460	59	47
More developed	606	297	10	na	na
Less developed	2334	1216	500	na	na

na=not available

Source: [1] Population Reference Bureau 1998; [2] UN 1992; [3] Mora and Mora 1999.

Table 2. Maternal nutrition status								
		Obstetric risk					BMI	
	Number	<145 cm	<45 Kg	<145 cm & <45 Kg	Total at risk	Neither risk factor	< 18.5	30+
AFRICA		%	%	%	%	%	%	%
Benin	2566	1.3	11.9	0.8	14.0	86.0	Na	na
Burkina Faso	4233	0.8	6.7	0.3	7.8	92.2	14.7	1
CAR	2408	1.6	10.4	1.6	13.7	86.3	Na	na
Comoros	899	2.4	12.2	1.6	16.1	83.9	Na	na
Cote Ivoire	3520	0.7	7.0	0.3	8.0	92.0	Na	Na
Ghana	1927	0.6	9.0	0.5	10.1	89.9	12.2	3.5
Kenya	3822	0.5	7.9	0.6	9.0	91.1	9.9	2.5
Malawi	2776	1.3	11.3	1.5	14.2	85.8	9.7	1.1
Mali	5064	0.5	7.4	0.4	8.3	91.7	Na	Na
Namibia	2581	1.2	8.9	0.4	10.5	89.5	13.9	7.6
Niger	4104	0.2	12.3	0.3	12.7	87.3	19.6	1.4
Senegal	3483	0.7	6.6	0.1	7.4	92.6	15.1	3.8
Tanzania	4364	1.8	10.2	1.7	13.7	86.3	9.8	2
Uganda	4120	1.4	8.3	0.9	10.6	89.4	na	na
Zambia	4525	0.8	7.6	0.8	9.2	90.8	11.4	2.5
Zimbabwe	2103	0.4	3.6	0.5	4.6	95.4	5.2	5.9
NORTH AFRICA								
Egypt	7539	1.4	1.7	0.3	3.3	96.7	1.6	23.9
Morocco	3354	1.6	4.5	0.5	6.6	93.4	3.8	10.9
Turkey	2650	2.2	3.3	0.3	5.8	94.2	2.6	18.4
LATIN AMERICA & CARIBBEAN								
Bolivia	2670	10.6	5.0	2.2	17.8	82.2	2.5	8
Brazil	3302	2.3	6.5	1.5	10.3	89.7	na	na
Colombia	3817	4.3	5.1	1.3	10.8	89.2	3.9	9.2
Dominica	2358	1.8	10.3	1.1	13.1	86.9	9	7.4
Guatemala	5413	20.1	6.8	12.8	39.8	60.2	3.8	8.2
Haiti	2271	1.7	13.9	1.2	16.8	83.3	na	na
Peru	10711	12.4	3.2	3.1	18.6	81.4	1.3	9.2
ASIA								
Bangladesh	4497	2.2	53.7	15.9	71.8	28.2	na	na
Nepal	3745	2.8	39.1	12.0	53.9	46.1	na	na
NEWLY INDEP. STATES								
Kazakstan	3707	0.6	5.4	0.4	6.4	93.7	na	na
Uzbekistan	4388	0.7	5.6	0.4	6.7	93.3	na	na

BMI=body mass index=wt/(ht^2)=not applicable. Source: S. Rutstein personal communication.

Table 3: Intervention points in the life cycle continuum

Life cycle Nutritional risks	Interventions to improve nutritional status and growth	Indicator (gender-based for all children)
Infancy and early childhood (<24 mos) C Sub optional breastfeeding C Inadequate and low quality diet C Micronutrient deficiencies C Frequent illness C Gender	C Exclusive breastfeeding for 4-6 mos	C % infants less than 24 months breastfed within 1 hours after of birth C % infants < 4 mo exclusively breastfed
	C Appropriate complementary feeding	C % infants 6-9 mos receiving breast milk and complementary food C % children < 12 mos receiving any food or drink from a bottle C % children 6-23 mos with height-for-age Z score <-2 C mean height-for-age Z score <-2
	C Prolonged breastfeeding	C % children 12-15 mos who are breastfeeding C % children 20-23 mos who are breastfeeding
	C Vitamin A supplementation	C % children 9-23 mos who received at least 1 vitamin A capsules in the last 12 mos C % children 9-23 mos with serum retinol < 0.7 umol/L
	C Iron supplementation	C % children 12-23 mos who received at least 6 mos of iron supplementation C % children 6-23 mos with Hb < 110 g/L or Hct <33% C % children 6-23 mos with height-for-age Z score <-2 C mean and standard deviation height-for-age Z score
	C Managed morbidity	C % children who experienced a diarrheal episode during the preceding 2 weeks who were given continues feeding C % children who experienced a diarrheal episode during the preceding 2 weeks who were given extra food
	C Malaria vector control (endemic areas)	C % children < 24 mos who regularly sleep under a bednet
Childhood (2-9 yrs) C Poor diet C Infections and parasites C Gender discrimination in food and health care	C Vitamin A supplementation	C % children 24-59 mos who received at least 2 vitamin A capsules in the last 12 mos C % children 9-23 mos with serum retinol < 0.7 umol/L
	C Iron supplementation (in supervised environment, e.g., early childhood learning center and primary schools)	C % children in educational settings that received 3 months iron supplementation C % children in institutions with Hb <115 g/L or Hct <34% C % children with height-for-age Z score <-2 C mean height-for-age Z score <-2

	C Deworming (endemic areas)	C % children 24-59 mos and 6-9 yrs (or in primary school) who received at least 2 anthelmintics in the last 12 mos C mean and standard deviation worm intensities for children 24-59 mos and 6-9 yrs (or in primary school) C % children 24-59 mos and 6-9 yrs (or in primary school) with Hb <115 g/L or Hct <34% C % children 24-59 mos and 6-9 yrs (or in primary school) with height-for-age Z score <-2 C mean and standard deviation height-for-age Z score for children 24-59 mos and 6-9 yrs (or in primary school)
	C Malaria vector control (endemic areas)	C % children 24-59 mos and 6-9 yrs who regularly sleep under a bednet
	C Institutional feeding , e.g., early childhood learning center and primary schools	C % children 24-59 mos and 6-9 yrs who go to an educational facility and eat a meal while there (school provided meal or meal bought from home) C % children 24-59 mos and 6-9 yrs with height-for-age Z score <-2 C mean height-for-age Z score <-2 C % children who attend school 90% of the time C % of children who drop out C % children who repeat a year
	C Nutrition and health education (schools)	C *Depends on behavior change being advocated*
Adolescence (10-19 yrs) C Inadequate food intake to meet increased demands for rapid growth C Anemia with onset of menstruation C Infections (including STDs) and parasites C Early pregnancy and lactation C Gender discrimination in food and health care	C Deworming through schools (endemic areas)	C % school children who received at least 2 anthelmintics in the last 12 mos C mean and standard deviation worm intensities C % children with Hb <120 g/L or Hct <34% C % children with height-for-age Z score <-2 C mean and standard deviation height-for-age Z score for children
	C Iron supplementation (schools)	C % children in school who received 3 mos iron supplementation C % children with Hb <120 g/L or Hct <36% C % children with height-for-age Z score <-2 or BMI-or-age <5th percentile C mean height-for-age Z score <-2 or mean BMI-for-age
	C Nutrition and health education (schools)	C *Depends on behavior change being advocated*
	C Prevention and management of STDs and other infections	C *Depends on nutrition-related behavior change being advocated*
	C School meals	C % children in school who eat a meal while there (school provided meal or meal bought from home) C % children with height-for-age Z score <-2 or BMI-or-age <5th percentile C % children who attend school 90% of the time C % of children who drop out C % children who repeat a year
	C Income-earning skill training	C *Depends on nutrition-related behavior change being advocated*

Adult women of reproductive age (20-49 yrs) C Food insecurity C Micronutrient deficiencies C Infections and parasites C Gender inequities C STDs and AIDS	C Family planning/birth spacing C Prevention and management of STDs C Income generation C Agricultural/gardening C Improved technologies C Adult literacy	C % women with CED C *Nutrition-related behavior change depends on change being advocated*
Pregnant women C Inadequate food intake to meet increased demands for fetal growth C Nutrition depletion syndrome C Micronutrient deficiencies C Maternal mortality C Low birth weight C Birth defects	C Increase intake of bioavailable nutrients and energy	C % women gaining 1.5 kg/mo in 2nd and 3rd trimesters C % women with mean weight gain of 1.5 kg/mo C mean and standard deviation weight gain
	C Malaria chemoprophylaxis (endemic areas)	C % primagravidae who received chemoprophylaxis
	C Deworming (endemic areas)	C % women who received at anthelmintics after the 1st trimester
	C Iron/folate supplementation	C % women who received supplements throughout the 2nd and 3rd trimesters C % women with Hb <110 g/L in 2nd trimester
	C Post partum vitamin A	C % women who received 200,000 IU vitamin A within 8 weeks post partum C % women with serum retinol or breast milk retinal <0.70 umol/L
Lactating women C Inadequate quality of breast milk for infant growth C Nutrition depletion syndrome C Micronutrient deficiencies	C Increase intake of bioavailable nutrients and energy	C % women with CED after 6 mos post partum
	C Iron/folate supplementation	C % women who received supplements through 3-6 mos post partum C % women with Hb <120 g/L at 3-6 mos post partum
	C	C
Post reproductive age (49+ yrs) C Undernutrition C Cardiovascular disease C Diabetes C Osteoporosis	C Good security	C % elderly with CED

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