Maternal and Infant Nutrition in Developing Countries
with Special Reference to Possible Intervention Programs
in the Context of Health

Subcommittee on Maternal and Infant Nutrition in Developing Countries
Committee on International Nutrition Programs
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References
1. **INTRODUCTION**

In response to a request from the Office of Nutrition of the U.S. Agency for International Development (AID), the National Research Council established the Subcommittee on Maternal and Infant Nutrition in Developing Countries to provide guidance to the Office of Nutrition for its expanding program in maternal and infant nutrition. The Subcommittee serves under the Committee on International Nutrition Programs of the Food and Nutrition Board, Commission on Life Sciences. The Subcommittee was asked to (1) review the state of knowledge of infant feeding practices and maternal nutrition in developing countries with a view toward program implications; (2) evaluate the scientific and operational basis of programs in breastfeeding, weaning and maternal nutrition; (3) evaluate program needs and guidelines; and (4) identify research priorities in the above areas.

The Subcommittee determined that the approach to this assignment that would best utilize its expertise was to review and evaluate the scientific basis of maternal nutrition and infant and young child feeding practices, especially those aspects that may form the basis for interventions. The Subcommittee felt it beyond its expertise and the time allotted for the task to systematically evaluate specific maternal and child health programs in developing countries.

To accomplish its task, each Subcommittee member prepared a paper on a specific topic in infant or maternal nutrition which then formed the basis for discussion of research needs and approaches to intervention. This report, which is a product of the entire Subcommittee, summarizes the Subcommittee's analysis of the scientific knowledge upon which interventions in maternal and infant nutrition can be based and identifies gaps in knowledge and recommendations for research.
The Subcommittee assumes, based upon discussions with AID Office of Nutrition staff, that the primary audiences for this report are AID field staff and Washington staff who have at least a general health background, but who may not have access to the literature cited here. Thus, the Subcommittee chose to present a summary of existing knowledge rather than an exhaustive literature review.

Several additional comments are necessary to provide the context for the Subcommittee review and recommendations and to understand the premises underlying the Subcommittee's analysis:

- Although the importance of nutrition and health during pregnancy as determinants of pregnancy outcome has been recognized for some time, a more comprehensive concern for the needs of the woman during other phases of her life cycle is only beginning to receive the attention it deserves. The Subcommittee endorses, and the report reflects, the more comprehensive approach that attention should be paid to women not only during pregnancy and lactation but also before they reach reproductive age and in between pregnancies. Furthermore, the period of lactation is approached not solely from the perspective of the infant's welfare, as has often been the case in the past, but also from the perspective of its effect on maternal nutrition and health status.

- A basic premise underlying this report is that nutrition and health must be considered as a unit. Given this premise, the Subcommittee is convinced that actions can be taken within the broad context of health that will improve the nutrition and health of women and young children in developing countries.
The Subcommittee also recognizes that nutrition and health are not an isolated unit and that in developing countries problems in growth, development, and attainment of full functional capacity have multiple causes, among which nutritional, sociocultural, economic, and environmental conditions and health care play synergistic roles. Consequently, interrelated non-nutritional factors need to be considered in the design, implementation, and evaluation of nutrition interventions. The Subcommittee is especially aware of the close association of socioeconomic status and nutrition.

Severe malnutrition is clearly a serious problem in a number of developing countries. However, for this report it is considered a medical problem that is not within the scope of the Subcommittee's charge. The primary concern in this report is prevention of mild and moderate (and hence, severe) malnutrition.
2. NUTRITION OF WOMEN AND CHILDREN--STATEMENT OF PROBLEM

2.1 Nutrition of Women of Reproductive Age

The paramount importance of nutrition of a woman during pregnancy and lactation for her own health and that of her offspring is widely recognized and has received increasing attention in recent years. In many Third World countries malnutrition is endemic, fertility rates are high, and women enter the reproductive stage at an early age and subsequently attain high parity. Maternal mortality rates are high and the incidences of fetal wastage, low birth weight, premature birth, and perinatal death are several times those reported for industrialized societies (PAHO, 1982).

Furthermore, from studies on women's roles in developing countries (Blair, 1981; Bekele, 1980; International Center for Research on Women, 1980; Loutfi, 1980; Eide et al., 1979, Huston, 1979), it has become evident that for poor women pregnancy and lactation do not interrupt the flow of daily activity. In communities where women carry heavy economic responsibilities, often as the sole or primary supporter of their children, neither pregnancy nor lactation can be allowed to disrupt the pattern of work. Under such circumstances, when food availability is also constrained, the physiological burden of pregnancy and lactation is immense.

Clearly, there must be behavioral and physiological adjustments for the majority of women to survive. Although it is important to learn more about the nature of these adaptive processes, it is even more important to understand the cost -- to women, their children and society -- of their adaptive adjustments. It is only by focusing on these, as well as on the many gaps in knowledge outlined in this report, that we can begin to comprehend the impact of nutritional deficits on maternal health and well-being and soundly plan our efforts for effective and efficacious correction of undesirable consequences.
2.1.1 Nutrition in Preparation for Reproduction

Undernutrition of future mothers during their growth and development is one factor influencing the reproductive life of women. One mechanism through which undernutrition acts is by delaying the age at which menstruation starts (menarche). For example, there is evidence that "undernourished" girls are older when menstruation starts (Bongaarts, 1980; Frisch et al., 1972; Dreizen et al., 1967), but are of similar skeletal maturation compared with "well-nourished" girls (Dreizen et al., 1967). Bongaarts (1980) succinctly reviews the evidence for a nutritional effect on menarche.

Recent reports based on data from industrialized countries suggest that menarche is delayed or amenorrhea may ensue when women, especially lean women, engage in heavy physical exercise (Frisch et al., 1981, 1980; Warren, 1980). Whether strenuous physical activity among young women in marginally nourished agricultural populations potentiates a delay in menarche is still unknown.

Whether delayed menarche constitutes a relative advantage for an "undernourished" group, because it allows time to attain a greater pelvic size, as seems to be the case for young "well-nourished" women whose menarche occurs later (Moerman, 1982), is still unknown. However, if chronic undernutrition delays pelvic growth as it delays menarche, any relative advantage of late maturation could be lost. Moreover, even if delayed maturation results in larger pelvic size at menarche (Moerman, 1982), there still may be other negative effects of poor nutrition on reproductive performance and maternal nutritional status, especially if pregnancy follows menarche promptly.

Although undernutrition may increase the age at which the birth canal reaches adult size, there is no conclusive evidence that undernutrition specifically alters pelvic growth except in cases of severe rickets occurring
during childhood and of osteomalacia. However, perinatal complications are more common among populations where nutrition problems exist, particularly if prenatal care is poor (for example, see Efiong and Banjoko, 1975). The contribution of cephalopelvic disproportion to these complications is still unclear as is the contribution of nutrition to pelvic growth. It is believed by a number of obstetricians practicing in developing countries that small pelvic size is a major cause of difficult labors and deliveries (Naeye, pers. comm.), but, again, conclusive evidence does not exist.

Chronic undernutrition resulting in maternal stunting, or acute or chronic undernutrition resulting in low prepregnancy weight, may also negatively affect reproductive performance as reflected in reduced newborn size and its attendant risks of mortality and morbidity. A positive association between maternal size (height and weight) and newborn size is widely recognized (Simpson et al., 1975; Siqueira, 1975; Niswander and Jackson, 1974; Habicht et al., 1973, 1972; Hytten and Leitch, 1971; Baird, 1962). The relationship between height and pregnancy outcome is confounded by the fact that maternal height reflects environmental, early nutritional, and genetic influences. The influence of height is also confounded by the fact that although height appears to have an independent effect on birth weight (Winikoff and Debrovner, 1981; Lazar et al., 1975; Niswander and Jackson, 1974), evidence from industrialized countries suggests that prepregnancy weight or pregnancy weight gain have a larger effect on birth weight than does height (Winikoff and Debrovner, 1981; Niswander and Jackson, 1974). The interaction of these effects is discussed in the next section.

In contrast to the work reported from industrialized countries, where women were on average taller and had better childhood nutritional status than is commonly found in developing countries, multivariate analyses of data from
a longitudinal study in Guatemala of the effect of supplementation on birth weight suggest that the independent contribution of height to birth weight is statistically significant (p < .05). This effect is as large as the effects of maternal weight and caloric intake from supplementation during pregnancy (Habicht et al., 1973). Furthermore, because the women studied came from villages where childhood growth, especially in height, is affected by differences in nutrition (Habicht et al., 1972), the authors assume that the adult height of the women studied was determined in large part by their childhood nutrition (Habicht et al., 1973). Thus, these findings suggest that, at least in this population, the mother's nutritional status during childhood and immediately preceding pregnancy are as important as determinants of birth weight as is maternal nutrition during pregnancy.

Another issue of concern in preparation for pregnancy, which has not been clearly defined, is the capacity for restoration during puberty and adolescence of growth deficits incurred early in life. Can effects of chronic undernutrition on height and lean body mass persisting into adolescence be ameliorated by improved nutrition during adolescence or later in life?

Lastly, we still lack considerable knowledge regarding what constitutes an optimal nutritional status as a preparation for pregnancy. With the possible exception of iron, additional information about critical levels of specific nutrient stores and ways to measure them are required before such levels can be suggested. Given current knowledge, the goal should be a dietary intake and a state of health which allows the population of women of reproductive age to achieve an adequate muscle mass and at least 16-18% of adipose tissue, 360-500 mg of iron reserves, and adequate levels of other vitamins and minerals.
2.1.2 Nutrition During Pregnancy

Clear negative effects of poor nutrition during pregnancy on maternal health and reproductive performance, including birth weight, are available. For example, it is generally recognized that in populations where chronic undernutrition is common, risk of low birth weight has been associated with increased risk of severe undernutrition, poor growth and development, and even death in infancy. In addition, famine during any part of pregnancy of enough duration to deplete maternal nutritional reserves has been shown to reduce birth weight and increase perinatal complications and mortality of both mothers and infants. However, depletion of maternal stores even due to famine during the first two-thirds of pregnancy may be compensated by adequate nutrition during the third trimester (Stein et al., 1975; Antonov, 1947).

Weight gain during pregnancy is an acknowledged determinant of birth weight. However, the size and importance of its effect (i.e., the amount of variability in birth weight explained by pregnancy weight gain) differs according to the condition of the woman entering pregnancy and reflects an interaction of weight gain during pregnancy and prepregnancy size and body composition. In the Collaborative Perinatal Project in the United States, birth weight increased significantly and perinatal mortality decreased as weight gain of thin mothers increased. However, birth weight and perinatal mortality were less sensitive to weight gain among normal and particularly among overweight women (Naeye, 1979). Winikoff and Debrovner (1981) also reported that weight gain explained most of the variability in birth weight for thin women, whereas prepregnancy weight was more important for women of intermediate weight for height. In their study thin women were defined as women with weights less than the lower limit for medium frame women of the Metropolitan Life Insurance Table of Desirable Weights and intermediate women
were those with weights within the medium frame range. In heavier women (defined by weight above the upper limit for medium frame women) weight gain was not a significant predictor of birth weight. Thus it appears that maternal reserves buffer the influence of diet such that when reserves are depleted diet becomes critical.

An average, well-nourished healthy woman irrespective of geographic or ethnic origin is estimated to gain 12.5 kg during pregnancy. Approximately 4 kg of this weight is considered to be fat deposited in different depot organs. Surveys of pregnancy weight gain conducted in Guatemala (Habicht et al., 1974), Ethiopia (Gebre-Medhin, 1977), The Gambia (Thomson et al., 1966), and India (Venkatachalam, 1960) show that a large proportion of the women gained between 2.7 and 6.8 kg. Although not all trials supplementing pregnant women have shown a positive effect on pregnancy weight gain (Rush et al., 1980), dietary supplementation studies in India (Raman, 1979; Iyengar, 1972), Bogota (Mora et al., 1979a, b), Guatemala (Lechtig et al., 1975a), and Mexico (Chavez et al., 1980) were associated with increased pregnancy weight gain, suggesting that the low weight gain is at least partially due to insufficient food intake. Recent supplementation studies in the Gambia showed a seasonal effect of supplementation on birth weight and pregnancy weight gain (Prentice et al., 1983). Thus, the authors suggest that mean monthly weight gain during pregnancy could be used to determine which communities would benefit most from prenatal supplementation (Prentice et al., 1983).

Evidence published primarily in the last decade indicates that placental growth and function are compromised by severe (Stein et al., 1975) and moderate (Lechtig et al., 1975b) maternal undernutrition (reviewed in Rosso, 1981). Although studies in humans of the mechanisms by which
malnutrition affects placental function have been limited, primarily for ethical reasons, a number of studies in rats show a reduced rate of placental transfer of nutrients in malnourished rats (Rosso and Kava, 1980; Rosso, 1977a, b). Reduced availability of specific nutrients could conceivably account for some of this impairment in nutrient transfer (Rosso, 1980). However, a more likely explanation is that inadequate maternal blood volume expansion (Rosso, 1981) is the mechanism through which undernutrition affects placental nutrient transfer.

Maternal blood volume normally increases by more than one liter during pregnancy (Hytten and Chamberlain, 1980). The increase is regarded as an adjustment that allows the pregnant woman to expand blood flow to her uterus without reducing blood flow to other vital organs. It is postulated that reduced blood volume expansion in turn results in an insufficient increase in cardiac output, decreased placental blood flow, and reduced nutrient transfer and placental size (Rosso, 1981, 1980).

No blood volume measurements have been published for women from undernourished populations in developing countries. Thus, there is no direct information about the importance of low blood volume expansion as a contributor to perinatal mortality rates. However, preliminary indirect analyses from the Collaborative Perinatal Project in the U.S. provide some information. In these analyses the presence of hands/facial edema was used as a proxy for adequate blood volume expansion. Hands/facial edema is positively correlated with blood volume expansion (Hytten and Chamberlain, 1980). When pregnancy weight gains were low, perinatal mortality rates were lower if hands/facial edema was present than if it was absent (Naeye, unpublished). This suggests that at least in thin women blood volume may be associated with perinatal mortality rates. These findings require validation.
Maternal acetonuria (ketonuria) has been hypothesized to be responsible for some of the excessive perinatal mortality associated with low pregnancy weight gain in the Collaborative Perinatal Project in the U.S. (Naeye, 1979). Increased plasma and urinary ketones are associated in pregnancy with the increased fat catabolism (increased use of fat as a fuel) that occurs during starvation (Felig and Lynch, 1970) and/or after short term fasting (12-18 hours) (Metzger et al., 1982). The increase in ketones (along with a decrease in glucose and other biochemical changes) is thought to be the result of the mechanisms operating to rapidly adapt the mother to the metabolism of fat so that glucose and amino acids can be spared for the fetus (Naismith, 1980). However, some of the lipid products may also cross the placenta and it is not known whether they are completely innocuous in the fetus (Metzger et al., 1982). Although there are data suggesting that newborn animals including humans have a heightened ability to use ketones for energy (Kerr et al., 1978; Dahlquist and Persson, 1976; Krebs et al., 1971), other mechanisms related to ketosis (e.g., acidosis, specific metabolic effects of acetone, widely fluctuating metabolic fuel substrates) may also have unexpected effects on the fetus. Currently, only indirect evidence links acetonuria with perinatal mortality and further elucidation of hypothesized mechanisms is required.

In most developing countries, the overall risk of exposure to various kinds of infections during gestation is considerable. Both overt and incipient intrauterine infections may cause fetal growth retardation or other clinical syndromes that may affect the fetus (for example, Mata et al., 1977). However, the relation of these infections to nutritional deficiencies (general or specific) has not been thoroughly investigated. Examples of questions
to be addressed include: Why is chorioamnionitis more prevalent in marginally nourished or moderately malnourished pregnant women than in well nourished women? What mechanisms are responsible for fetal growth retardation among pregnant woman with urinary infections? Are they equally damaging among pregnant women of varying nutritional states? Are acute phase immune responses equally effective in pregnancy as when a woman is not pregnant? Are there nutritional interrelations? The well known infection-induced defect in utilization of fat as a metabolic fuel may be particularly deleterious during pregnancy because of the greater dependency on fat as an internal source of fuel under those conditions (Naismith, 1980).

Some evidence suggests that zinc deficiency is related to preterm labor and delivery (Naeye and Friedman, 1979). It has been hypothesized that zinc deficiency results in reduced antimicrobial activity and therefore amniotic fluid bacterial infections (Applebaum et al., 1979; Naeye and Friedman, 1979). Further work is needed, however, to validate this hypothesis. If it is true, additional work will be needed to determine, given other nutritional and non-nutritional factors influencing preterm delivery, whether the contribution of zinc deficiency as a contributor to preterm labor and delivery is a public health problem and amenable to intervention.

Degree of physical work during pregnancy may also affect the health of the mother and the outcome of pregnancy. Several investigations demonstrate that pregnancy weight gain and pregnancy outcome (birth weight) improve if a woman maintains energy balance by reducing physical work to counterbalance reduced dietary energy intake (Tafari et al., 1980). However, more systematic data are required to determine if changes in physical activity have an effect on pregnancy outcome when dietary intake is adequate. In other words, the effect of physical activity on pregnancy weight gain and outcome throughout the range of dietary intakes is not understood.
Other factors to consider during pregnancy, at least in some developing countries, are a woman's habitual alcohol intake and smoking habits. Alcohol is a fetal toxic agent throughout pregnancy, producing different types of fetal anomalies including fetal-alcohol syndrome (reviewed in Abel, 1982; Hanson, 1982). A deleterious effect of smoking on fetal growth is also well recognized (Longo, 1982; Garn et al., 1982; Siegal and Morris, 1970). The possible role of adequate nutrition in correcting and possibly preventing the effects of smoking on fetal growth and development deserves greater attention. Whether a high concentration of smoke and carbon monoxide, observed in closed highland dwellings with a central open fire, as found in some developing countries, has a similar effect as smoking, and whether it has nutritional impacts, is still unclear.

In many developing countries anemia during pregnancy is a recognized public health concern. Reported prevalence of anemia (expressed as the percent of women with hemoglobin values less than 11 g/dl) for women in tropical Asia in the third trimester of pregnancy range from 35% in urban Nepal, to 66% in Bangladesh, to 72% in the Philippines, and to 88% in India (Baker, 1981). A large collaborative study in Latin America reported a prevalence of 22% for third trimester pregnant women (Cook et al., 1971).

The most common causes of anemia are dietary intake deficiencies, malabsorption defects, blood losses, infections and infestations, and in certain areas, hemoglobinopathies. In general, iron deficiency is the commonest causes of anemia (WHO, 1975a). In pregnant women folate deficiency is also an important cause (Baker, 1981, 1976).

Severe anemia in pregnant women is associated with an increased risk of premature delivery and maternal morbidity and mortality. Mild to moderate anemia (small reductions in hemoglobin) caused by severe iron deficiency has
been shown to decrease performance in maximum or near maximum exercise in humans (Cifuentes and Viteri, 1972; Viteri and Torun, 1974) and alter mitochondrial energy metabolism and hormonal balance in animals (Davies, et al., 1982; Dillman et al., 1979; Finch et al., 1979, 1976). There is also some evidence that mild to moderate anemia may limit performance of tasks involved in daily occupations (Basta et al., 1979; Edgerton et al., 1979). Lastly, there is some experimental evidence that iron deficiency anemia may be related to reduced resistance to infection and impaired immunity (reviewed in Bothwell and Charlton, 1981; Baker and DeMaeyer, 1979). However, current findings are not conclusive, and the subject requires further controlled study.

Iron and folate supplementation have been shown to effectively increase the hemoglobin concentration of pregnant women (for example, Izak et al., 1973 in Israel; Aung-Than-Batu et al., 1976 in Burma; Sood et al., 1975 in India). The Narangwal studies in the Punjab suggest that maternal iron and folate supplementation of pregnant woman contributed to a decrease in perinatal mortality (Kielmann et al., 1978).

2.1.3 Nutrition in Relation to Pregnancy During Adolescence

A special case of nutrition and growth related to reproductive efficiency is that of pregnancy during adolescence, because two components of growth (maternal and feto-maternal) take place simultaneously. A number of studies of pregnancy in adolescence carried out in developed and developing countries indicate that rates of low birth weight and prematurity are higher in the young, physiologically immature adolescent than in mature women (Naeye 1981; Siqueira et al., 1981; American Academy of Pediatrics, 1979; Bremberg, 1977; Efiong and Banyoko, 1975; WHO, 1975b). There are exceptions to this
evidence, however, such as that presented by Zuckerman *et al.* (1983), which shows no such association for a group of pregnant adolescents in Boston. There is little, if any, information from developing countries about whether early pregnancy has a deleterious effect on maternal nutritional status.

Agreement is lacking on the severity and incidence of pregnancy and labor complications, partially because of methodological differences among studies. However, it appears that the risks for pregnant adolescents under 16 and their infants are high (WHO, 1975b). For example, although not universal (Zuckerman *et al.*, 1983), there is evidence suggesting that the incidences of toxemia and pre-eclampsia are significantly higher among young adolescents than any other group of reproductive age (WHO, 1975b). Whether this is nutrition-related is not clear, however.

Although dietary practices contribute to the increased risks of early pregnancy, inadequate prenatal care (Efiong and Banjoko, 1975; Dwyer, 1974), low socioeconomic status (American Academy of Pediatrics, 1979), unmarried mother (Osbourne *et al.*, 1981), and inadequate social support systems (WHO, 1975b) have been associated with adolescent pregnancy and its risks. Thus age *per se* may not always be a risk factor (Zuckerman *et al.*, 1983). There is still some debate about the relative importance of chronologic age and gynecologic age (years after menarche) for the outcome of pregnancy (Moerman, 1982; Zlatnik and Burmeister, 1977). Although the importance of gynecologic age in developing countries is not well understood, data from industrialized countries suggests that reproductive performance is poorer among adolescents who become pregnant within two years after the onset of menarche (Zlatnik and Burmeister, 1977). Again, however, the data available suggest that although low maternal age is a risk factor, environmental, social, health, and
Nutritional conditions surrounding young childbearing are likely even more important determinants of a successful early pregnancy outcome.

2.1.4 Nutrition During Lactation

Factors affecting milk production and the effect of milk on infant growth have been the main focus of recent lactation research. Maternal nutritional status and other maternal characteristics are almost always examined in relation to their effects on milk quality and quantity. Very rarely is the direction reversed to inquire about effects of lactation on the mother. Historically, this has probably occurred for several reasons. Firstly, high rates of infant mortality have led to a focus on nutrition as a determinant of infant mortality. This, in turn, led to a tendency to see the lactating mother as a vehicle through which nutrients are delivered to the infant, with a research emphasis on how milk quality and quantity affect infant health. Secondly, when nutrition researchers have studied maternal nutrition, they have been more likely to focus on pregnancy than on lactation because it generally has been perceived, although not tested, that feto-maternal nutritional interactions which take place during pregnancy are more important than infant-maternal interactions occurring during lactation, and that pregnancy places a greater strain on maternal resources than does lactation.

Little information about direct effects of lactation on maternal nutritional status has been compiled in the literature. To help fill this gap the discussion of nutrition during lactation presented in this report concentrates on effects of lactation on the mother's nutritional status and includes review of three factors which may have particular effects on maternal nutritional status during lactation—culturally determined food restrictions, contraception, and
infection. The effects of maternal nutritional status on milk yield and composition have been extensively reviewed (Whitehead, 1983; Jelliffe and Jelliffe, 1978) and are summarized only briefly here.

Maternal Nutritional Status During Lactation

Knowledge about maternal nutrient requirements and standards for assessing maternal nutritional status during lactation are inadequate. For most nutrients, current published standards for lactating women have been derived by adjusting requirements for nonpregnant, nonlactating women upward to include the additional amounts of nutrients in human milk. For some nutrients, knowledge of requirements in the nonlactating woman is highly inadequate. That is, the reference base on which to add the additional requirements of lactation is not secure. In addition, a requirement may be based on assumptions not applicable to women living in developing countries. For example, the assumption of an 80 percent efficiency in the conversion of food energy to milk may not always be correct. Similarly, the assumption of a highly effective transfer of nutrients from maternal plasma into milk has been studied very little in humans or experimental animal models.

From a review of available evidence we conclude that the current state of knowledge about the effect of lactation on nutrient requirements and nutritional status of women in developing countries is inadequate and that generalizing from such an inadequate data base must be done cautiously. A more detailed review of the specific effects of lactation on maternal energy balance, and protein, vitamin, and mineral status is presented in Appendix A.

There is a widespread belief in the health care, nutrition, and social science communities, that cultural food restrictions practiced by breastfeeding women have deleterious consequences for maternal and infant
health. There is evidence from many parts of the world that beliefs concerning the importance of lactation food restrictions are very common (for example, see Ferro-Luzzi, 1980). However, although the literature contains numerous discussions of types of lactation restrictions (Rosenberg, 1980; Valdecanas, 1971), often with ethnographic examples, little solid research addresses the impact of cultural food restrictions or dietary changes in general on the health and nutritional status of lactating women.

The effects of hormonal contraceptives on the nutritional status of lactating women appear to be no different from those on nonlactating women (WHO/NRC, 1983). For example, Prema and colleagues (1981a) found no effects of a low dose injectable progestational contraceptive on the nutritional status of low-income, lactating Indian women as assessed using anthropometric techniques and clinical signs of nutritional deficiencies. There is, however, some evidence that vitamin B6 requirements may be changed in women who use oral contraceptives (Adams et al., 1974; Rose et al., 1973). Roepke and Kirksey (1979) demonstrated that long-term use of oral contraceptives prior to pregnancy significantly decreased the levels of vitamin B6 in maternal serum and in breast milk.

Recent evidence from the Gambia (Lunn et al., 1980), Guatemala (Delgado et al., 1979), India (Prema et al., 1981b), and Zaire (Carael, 1978) suggests that improving the nutritional status of breastfeeding women in developing countries may upset the hormonal mechanisms prolonging postpartum amenorrhea, shorten the period of postpartum amenorrhea, and, in the absence of alternative contraceptive techniques, cause fecundity and fertility to rise, i.e., reduce the contraceptive effect of breastfeeding. However, analyses of other data suggest that the impact on fertility of improved maternal nutritional status is modest (reviewed in Huffman, 1982; Huffman et al., 1980 and Winikoff, 1978).
Another explanation for a shortened period of postpartum amenorrhea is that supplementing an otherwise fully breastfed infant reduces the intensity and/or frequency of sucking and therefore alters the hormonal balance maintaining the period of amenorrhea (Prema and Ravindranath, 1982; Howie et al., 1981; Delgado et al., 1979). Both of these hypotheses require further investigation and may have important consequences for program planners in nutrition who may have to improve contraceptive services at the same time that they are improving the nutrition of lactating women or their nursing infants.

In the large literature on nutrition-infection interactions, we were unable to identify any empirical studies in developing countries that focused specifically on the effects of maternal infection on nutritional status during lactation. Does lactation create special conditions that influence the course and severity of infection? What is the prevalence of mastitis and its impact on the health status of poorly nourished women? These and related questions require further study.

Maternal Nutritional Status and Milk Production

Studies of human milk production and composition in both well and poorly nourished communities in different ecological circumstances have had different emphases and methodologies (Jelliffe and Jelliffe, 1978). As a result inferences and comparisons must be made cautiously. Studies carried out in different population groups seem to indicate that mean breast milk output in mothers from privileged populations tends to range from 600 to 900 ml/day (summarized in Whitehead, 1983). Volumes of breast milk reported for women in countries with undernutrition and poor living conditions range from about 400-700 ml/day in the first six months, 300-600 ml/day in the second six months (summarized in Whitehead, 1983), and 300-500 ml/day in the second year
(summarized in Jelliffe and Jelliffe, 1978). Higher figures of 700-1,000 ml/day have been reported for non-privileged Ethiopian women (Gebre-Medhin, unpublished).

Available information seems to suggest that the quality of human milk is remarkably preserved even in the mildly-moderately malnourished mother except in advanced deficiency states (Jelliffe and Jelliffe, 1978; Thomson and Black, 1975), although the evidence for an effect on quantity is not as good. For example, in famine milk output may decline and ultimately cease. Marasmus in the first six months of life may occur in babies of very poorly nourished women. Although the concentration and the content of individual nutrients in breast milk may be somewhat reduced in malnourished mothers compared with healthy controls, breastfeeding even by malnourished mothers seems capable of achieving adequate growth and nutrition in the early postnatal period. The determinants of milk production in humans are not well understood, but the stress associated with living under difficult socioeconomic conditions is considered an important cause of variation in milk yield. The effect of maternal disease burdens on milk composition and volume is also not understood well.

Although as mentioned earlier hormonal contraceptives may not affect maternal nutritional status directly, there is concern that estrogen containing contraceptives may decrease milk output (WHO/NRC, 1983; McCann et al., 1981; Hull, 1981) and could result in early termination of breastfeeding and/or infant growth retardation. For example, combined estrogen-progestogen oral contraceptives containing as little as 30 ug of estrogen have been reported to significantly decrease milk volume (Koetsawang, 1982). When used in the first few months of the postpartum period, these contraceptive agents can decrease milk volume by as much as 40% within 3-6 weeks (WHO/NRC, 1983).
Until recently it was thought that hormonal contraceptives containing 50 ug or less of estrogen did not affect infant growth (McCann et al., 1981). However, preliminary results of at least one study suggest that this may not be the case (Zeitlin, pers. comm). Given their widespread implications for infant health in developing countries, these findings require further clarification. Until results of such studies are available, current knowledge, as summarized by the recent WHO/NRC Joint Workshop on Breastfeeding and Fertility Regulation (WHO/NRC, 1983), suggests the following: 1) The appropriate time for introducing contraceptive techniques other than lactational amenorrhea varies among social groups and therefore should be set by family planning and health officials on the basis of breastfeeding and lactational amenorrhea patterns in their specific situations; 2) If contraceptive use is deemed necessary, nonhormonal contraceptives should be encouraged for lactating women; 3) For lactating women who wish hormonal contraceptive protection in the early months of lactation, progestogen-only hormonal contraceptives should be made available and women should be warned about the effect of combined oral contraceptives on the quantity of breast milk (WHO/NRC, 1983).

2.2 Nutrition of Infants and Young Children

The presence and extent of poor childhood nutrition in a population can be assessed in various ways. Impaired physical growth (e.g., weight and length or height) is perhaps the most useful indicator. Although lacking specificity, growth is a very sensitive indicator of nutritional adequacy. It is possible that other functional alterations, such as those reflected in decreased physical activity and psychosocial interaction and mental well-being, occur during malnutrition prior to evident reductions in growth.
rates. However, anthropometric measures of physical growth are still the simplest means of assessing adequate nutrition at the population level, while other functional impairments are difficult to quantitate.

Available data on physical growth document that infants in developing countries almost universally begin to lag behind their counterparts in industrialized countries by the middle of the first year of life and continue to do so for the ensuing years (Waterlow et al., 1980). Although non-nutritional factors, including infection, undoubtedly play an important role in growth retardation, inadequate food intake is an important factor.

More dramatic evidence of inadequate nutrition is provided when frank malnutrition in its various clinical manifestations is observed. Severe malnutrition is often life-threatening and presents serious problems of treatment and rehabilitation. Severe malnutrition also has profound negative effects on immunity and resistance to infection. Impaired immunity is responsible for much of the increased frequency and severity of infectious illnesses. In the case of infectious illnesses, especially diarrhea, the illness itself may lead to more malnutrition, and set in motion the vicious malnutrition-infection cycle (Chandra and Newberne, 1977). Impaired bodily defense against infection contributes substantially to the high death rate among infants and young children in developing countries.

The occurrence of cases of overt malnutrition may provide a marker of poor nutriture existing in a community. Thus, the occurrence of even a few cases of severe childhood malnutrition in any given community suggests the presence of significant nutritional problems perhaps involving large segments of the susceptible population.
Mortality statistics also often provide evidence of inadequate nutriture. Although infection is often the primary cause of death, malnutrition is associated with a large proportion of deaths occurring in developing countries. Kielmann and McCord (1978) and Chen et al., (1980) have demonstrated an inverse relationship between weight-for-age and mortality. Much of the weight deficit is due, directly or indirectly, to inadequate nutrition. Inadequate nutrition and its consequences are important contributing factors to the increased mortality in infancy and childhood.

Reduced physical activity and impaired psychosocial functioning are commonly observed in poorly nourished children. These factors may in turn cause impaired interaction with other family members, and result in impaired cognitive and psychosocial development. The behavioral effects of malnutrition are difficult to separate from the effects of early malnutrition on the development of the central nervous system. Whatever the more important of the two mechanisms may be, there is no doubt that inadequate nutrition and poor psychosocial environment during early childhood can have adverse effects on intellectual and psychosocial development.

Limited food intake associated with restricted cultural or physical availability of foods or with insufficient purchasing power is an important cause of malnutrition, in conjunction with poor sanitary conditions and insufficient knowledge about nutritional needs. However, even when general causes of malnutrition are understood, specific local conditions need to be explored to identify combinations of causative factors which may be amenable to intervention. For example:

- Poor maternal nutritional status plus infections during pregnancy have been shown to be determinants of low birth weight. Poor nutrient intake during lactation, combined with heavy physical
labor, may lead to diminished milk production. These factors often contribute substantially to early faltering of growth, which begins before diarrheal disease begins to play a role (Mata, 1978).

In some cultural settings late introduction of complementary foods is common practice. Often these foods are of less than ideal composition, i.e., caloric density is low, protein content is low. Furthermore, if the complementary foods are prepared and fed under poor sanitary conditions, they become major sources of pathogens contributing to weanling diarrhea.

Frequent infectious illnesses, especially diarrhea, contribute toward insufficient food intake in children and result in anorexia, lethargy, and diminished nutrient absorption.

Each of these causes of malnutrition of infants and children is susceptible to intervention. Clearly the chances of success are greatest if intervention simultaneously aims at all causative factors operating in a given population.

A discussion of nutrition in infancy would be incomplete without comment on breastfeeding, complementary foods, and weanling diarrhea. Thus, the remainder of this section will highlight these interrelated topics.

Breastfeeding and Complementary Foods

In many traditional societies breastfeeding is a common practice. Over the past several decades, however, the incidence and duration of breastfeeding has declined in many countries particularly in urbanized areas (McCann et al., 1981; WHO, 1981a). This has aroused concern among the health and nutrition communities (for example, WHO, 1979).
Where breastfeeding is practiced, breast milk usually provides the sole source of nutrients during the early months of life. At some point during the first year of life, complementary foods should be introduced, but breastfeeding often continues through the second year of life (McCann et al., 1981). The advantages of breastfeeding are well recognized and will not be further elaborated here.

The age at which breast milk alone becomes an inadequate sole source of nutrients appears to be influenced by maternal nutritional status and is subject to great individual variation. Under favorable circumstances, breastfeeding alone is capable of meeting an infant's nutritional requirements and of supporting normal growth for the first four to six months of life (Whitehead and Paul, 1981; Waterlow et al., 1980; Waterlow and Thomson, 1979).

Where undernutrition and deprivation are prevalent, available data indicate that growth faltering in exclusively breastfed infants may occur before three months although it is generally not evident until after three months (Waterlow et al., 1980; reviewed in Underwood and Hofvander, 1982). Thus, under some conditions breast milk may be an insufficient sole source of nutrients by three months. However, the situation is complicated by increasing exposure of the child to infection at a time when its passive immunity is dwindling (Waterlow and Thomson, 1979).

There has been considerable controversy regarding the age at which complementary foods should be introduced. (Complementary foods are any foods an infant or child receives in addition to breast milk.) Some advocate categorically that in well-nourished and healthy populations complementary food should not be introduced until an infant is older than six months, unless growth is faltering. Another view considers the risks and long-term
consequences of early growth failure and decreased immunological competence due to undernutrition to be potentially grave. Consequently, this second view favors introduction of complementary foods even before growth failure is evident. The problems attendant to introduction of complementary foods are potentially solvable, and therefore this view contends that the prudent approach is to concentrate on making the introduction of complementary foods safer for the infant.

The age at which complementary foods become necessary varies greatly, as mentioned earlier, with variation between individuals probably being larger than variation between communities. An individualized approach in populations or in communities at risk is therefore necessary. As has been emphasized by Scrimshaw and Underwood (1980), the best way to determine when complementary foods are necessary is through monitoring of body weight. Although there are logistic problems associated with frequent weighing, potential benefits can be substantial. Thus, regular monitoring of body weight should be encouraged and facilitated.

Traditional complementary foods are often of low caloric density (Whitehead, 1976), low protein content, contain little or no fat, and are often limited in micronutrient content. Such foods are not well suited to supplement the breastfed infant's diet. Development and use of appropriate foods need to be promoted. Representative complementary foods are described in Cameron and Hofvander (1976), and several examples are presented in Appendix B.

Weanling Diarrhea

The introduction of complementary foods is one factor, along with environmental contamination and poor hygienic practices, commonly associated with diarrhea. Typically, a child will already be in a suboptimal nutritional
state (as evidenced by suboptimal weight) at the time he/she is first given complementary foods. These foods are often contaminated (Rowland et al., 1978; Mata, 1978) and fed under poor sanitary conditions, e.g., from unwashed hands or after having been dropped on the floor. This increases the force of infection in a child who often has repeated infectious episodes. Moreover, the child's defenses against infection may be impaired as a result of his/her poor nutritional state and the child often develops diarrhea with this additional burden. Diarrhea entails impaired intestinal absorption and often anorexia, which aggravate the existing nutritional state. Soon another episode of diarrhea follows resulting in more nutritional deficit and further impairment of host defenses. Thus, a vicious cycle is set in motion which is difficult to break once it has been established.

Recurrent diarrhea is responsible for much of the growth deficit seen among children in developing countries (Rowland et al., 1977; Mata, 1978). Clearly, measures effective in preventing or ameliorating the malnutrition-diarrhea cycle are potentially a major influence on childhood nutrition. Efforts to prevent establishment of the cycle should thus receive high priority.

3. GAPS IN KNOWLEDGE

3.1 Gaps in Knowledge Related to Maternal Nutrition

3.1.1 Nutrition Prior to Pregnancy

There is evidence that marginally nourished women entering pregnancy have a greater risk of impaired reproductive performance when compared to better nourished women in similar settings. It would appear that the risk is
even more critical in young adolescents. However, the mechanisms of the interaction of stunting as a result of past undernourishment and of maternal and infant risk (particularly in girls less than 16 years of age) are poorly defined. Specific physiological and operational research questions associated with chronic undernutrition and stunting, and with early pregnancy in general, include the following:

- Is pelvic growth in adolescence a critical issue in reproductive risk among stunted populations?
- Are dystotic deliveries (deliveries with difficult labor) more common among these populations, and if so, why?
- Can effects of chronic undernutrition on height and lean body mass persisting into adolescents be ameliorated by improved dietary intake during adolescence or later on in life?
- Is increased gynecologic age (time after menarche) a favorable factor for a successful pregnancy among these women? If so, the following operational research questions arise:

  --Can sociocultural interventions that encourage delaying pregnancy be effective in improving reproductive performance and in reducing the number of pregnancies at an early reproductive age?
  --How important as a means to encourage delaying early pregnancy are social support systems and the perceived value of women by the family and community?
  --How effective in delaying pregnancy and improving reproductive performance and infant health are measures directed toward encouraging community and family support compared with direct nutrition interventions?
--In this context, how effective in reducing risks for a next pregnancy is food supplementation during pregnancy and lactation compared with simple birth spacing?
--What is the relative benefit of improved prenatal care exclusive of direct food supplementation in improving reproductive performance of adolescents?
--What are the impediments to obtaining improved prenatal care and increasing its coverage?

Another major gap in our understanding of nutrition as a preparation for pregnancy is that there is no clear definition of optimal pre-pregnancy nutritional status. Therefore the effect of interventions often is difficult to determine.

3.1.2 Nutrition During Pregnancy and Lactation

Fundamental gaps still exist in our knowledge of the interplay between the processes of physiological adaptation to pregnancy and lactation and mild-moderate nutrient (and energy) deficiencies and/or the demanding lifestyles of many agricultural societies. These gaps, for example, are reflected in the relatively scarce data upon which to base nutrient (and energy) requirements during pregnancy and lactation and to determine their normal variability under usual living conditions of developing populations. In this section gaps in knowledge have been categorized according to whether they primarily concern physiological mechanisms (a-g) or operational aspects of interventions (h-m). The Subcommittee believes that priorities for operational research and specific operational constraints are determined by local situations. Therefore, items h-m present general operational research questions which must be further refined and adapted to local conditions and
priorities. The following are priority questions related to physiological mechanisms.

a) What are the limits of normality for healthy pregnant and lactating women for both maternal and fetal well-being? What is the basis for interpreting changes in the levels of nutrients and other substances in maternal and fetal circulation? Is there a point at which these changes warrant nutritional intervention? Can changes in nutrient levels be useful in monitoring pregnancy and lactation? What energy, protein, and other nutrient reserves are adequate to ensure satisfactory fetal development in the face of various levels of dietary inadequacy during pregnancy? Conversely, what threshold in calorie or protein consumption must be surpassed in order to translate increments in maternal dietary intake into increments in birth weight?

b) What is the effect of physical activity on weight gain and outcome of pregnancy throughout the range of maternal dietary intakes? Specifically,

- Are there harmful effects of physical activity? If so, do they occur throughout pregnancy and lactation or are certain periods more vulnerable?

- Could increased dietary intake provided by food supplements negate any harmful effects of increased physical activity?

- Are there benefits to continued activity with adequate dietary intakes?

- Can reproductive performance be improved by reducing physical activity when the dietary intake is marginal? Again, are there time constraints?
o Are there synergistic beneficial effects of increased food intake and reduction in activity? If so, at what point(s) during pregnancy and lactation do these effects occur?

c) What are the mechanisms by which maternal dietary deficits limit transfer of nutrients to the fetus? If blood volume expansion is a critical factor could such measures as high hemoglobin and hematocrit and absence of hands/facial edema be used in field settings as indicators of insufficient blood volume expansion? Are there practical measures which can be used in conjunction with nutritional interventions to overcome insufficient transfer of nutrients?

d) If the "normal" ketogenic response to fasting and to negative energy balance is exaggerated during pregnancy, does it have a deleterious effect on the fetus and/or on "normal" mechanisms of labor and delivery? Could ketonuria be a sensitive indicator of energy deficit during pregnancy (operational)?

e) Are the mechanisms by which fatty acids become a more important source of metabolic fuel during pregnancy particularly susceptible to fail because of infection thus inducing rapid and acute metabolic energy deficits? Could simple dietary recommendations be conceived to reverse this effect if it exists?

f) Does lactation create special conditions that influence the course and severity of infection? What is the prevalence of mastitis and its impact on the health status of poorly nourished women?
g) Does maternal nutritional status influence a woman's capacity to lactate sufficiently to support her infant's catch-up growth following an infectious episode? In situations where dietary intake is often inadequate, does long-term lactation deplete maternal reserves and affect such factors as pregnancy outcome, maternal quality of life and health, and parenting ability? What is the impact of cultural lactation food restrictions or dietary changes in general on maternal health?

The following priority questions are related to operational (program-related) aspects of interventions aimed at improving nutrition and health during pregnancy and lactation.

h) What combination of socioeconomic and biological risk factors can be used for identifying target populations and monitoring and evaluating interventions? Although sufficient evidence exists to identify some risk factors for pregnant women (see Sections 2.1.2 and 4.2.1 and WHO (1981b)), more methodological/statistical research is needed, for example, to determine best combinations of risk factors for specific purposes. Furthermore, although a number of risk factors have been identified (WHO, 1981b), the characteristics (sensitivity, specificity, predictive value) of these factors as indicators of nutritional status of populations and their appropriate uses given different purposes (assessment, monitoring, evaluation) require further study. Until this is done the definition of groups at risk, the institution of potentially effective nutritional interventions, and the evaluation of their impact (e.g., Beaton and Ghassemi, 1982; Mason et al., 1982; Habicht and Butz, 1979) are hampered.
i) What is the cause of maternal complications during the perinatal period (prepartum, labor and delivery, puerperium)? Are there interactions between general nutritional status and/or specific nutrient deficiencies and infection? Are specific behavioral factors and practices prior to, during, and immediately after delivery responsible for complications?

What is the predominant cause of complications during delivery? Is dystocia (difficult labor and delivery) a common event and, if so, why? The whole issue of pelvic growth and previous nutrition becomes very relevant in this regard.

j) What is the contribution of specific nutrient deficiencies during pregnancy to pregnancy outcome? In the case of zinc in particular, how can its deficiency be diagnosed during pregnancy? Can improved zinc nutritional status improve defense mechanisms during pregnancy? Can it reduce the frequency of chorioamnionitis and preterm delivery? If so, can zinc supplementation to pregnant women reduce the frequency of these complications without harmful side effects?

k) What are the effects of introduction of complementary foods and of maternal nutritional status on the duration of postpartum anovulation and fertility? Are these effects independent? Synergistic? Do low-dose estrogen-containing oral contraceptives have a reproducible negative effect on milk quality and quantity and on infant growth? If so, is it of public health significance?
1) What standardized nutrition research methodology and documentation on pregnant and lactating women is required for accurate interpretation and comparison of research during pregnancy? Much of the controversy about the evidence for a detrimental effect of maternal malnutrition on fetal well being stems from the use of different methodological approaches. Wide differences exist in the severity and character of maternal malnutrition between the groups investigated. These discrepancies are particularly large when comparison is made between industrialized and less developed countries. Surveys have been carried out at different times during pregnancy, and the methods used have not had the same level of precision. The subjects investigated have not always been comparable. In most instances, account has not been taken of these and many other important intervening variables.

m) What are the minimal needs for prenatal care within different human ecological settings? What risk factors are most useful in defining target populations for prenatal care given specific local conditions? Within different cultural settings, what determines the attendance to prenatal care and to delivery in an institution or at home assisted by obstetrically trained personnel?
3.2 Gaps in Knowledge Related to Infant and Young Child Nutrition

Although understanding of physiological and biochemical mechanisms related to infant and child nutrition is by no means complete, there is a core of basic knowledge in such areas as breastfeeding, complementary foods, weanling diarrhea, and growth monitoring upon which interventions can be designed. A number of operational impediments to application of basic knowledge still exist, however. Therefore, in this section the Subcommittee has focused primarily on program-related (operational) questions, although in some case operational and physiological questions overlap.

a) The incidence and duration of breastfeeding are declining in populations undergoing transculturation (urbanization, "modernization"). There are complex reasons for the decline but changes in the environment, especially the sociocultural environment, are important (ESPGAN Committee on Nutrition, 1982; Vis and Hennart, 1978). Given the importance of breastfeeding for infant health, development of effective actions to promote breastfeeding under these conditions is important. This requires more knowledge than currently exists of sociocultural determinants of breastfeeding practices.

b) In low socioeconomic groups in developing countries, what is the growth pattern of fully breastfed infants during the period that growth appears to proceed normally? How long is this time? What determines the length of the period of adequate growth for individual infants? That is, what are the determinants of growth faltering? Is it due to differences in milk yield and composition? Intercurrent infection? Synergism between breast milk intake and
infection? Are there other possible functional impairments which precede or accompany a decrease in growth velocity?
c) The contribution of complementary foods to a shortening of the duration of breastfeeding is still poorly understood. Questions that need to be answered include:

- Is there a ratio of food to breast milk which is optimal for infant growth and maintenance of breastfeeding?
- Is there a frequency and sequence of feeding semi-solid complementary food and breast milk that is optimal for infant growth and maintenance of breastfeeding? Preliminary observations indicate that offering semi-solid complementary foods shortly before offering liquid formula or human milk increases the amount of the liquid consumed or at least does not decrease it (Viteri, personal communication). This may occur because the semi-solid food does not have the thirst quenching (water electrolyte) effect of the liquid milk. These findings are contrary to conventional wisdom, which advocates breastfeeding before offering semi-solid foods and, if validated, will have significant practical implications.

- Experience suggests that complementary foods should be introduced when an infant is between 4 and 6 months old (Underwood and Hofvander, 1982). However, the evidence for beneficial or harmful effects on infant health and nutritional status of introducing foods to infants from low socioeconomic groups at 3–4 rather than 5–6 months is insufficient to make a sound pronouncement on the issue. Such results are especially relevant for women who must be away from their infants for large parts of the day or night.
d) Once an infant or young child suffers from diarrhea and is being rehydrated by mouth or parenterally what should the child be fed? How should different foods be prepared and how should they be offered to the child?

Current practice advises mothers to feed their babies early in these circumstances, although not much is known in this area. Much less is known about the appropriate regimen which will allow catch-up growth or nutritional repletion after diarrhea. Intensive feeding during or immediately after acute infections (5-7 days) may lead to catch-up growth (as seen in malnourished children) with growth rates reaching three to five times normal for spurts of a few days. Studies of intensive feeding in convalescence, including the role and capacity of breastfeeding, are certainly a promising area of inquiry. Whether extensive feeding is practical at the community level is a separate question which must also be answered.

e) **Growth monitoring** can be a key tool to early detection and effective preventive action to avoid protein-energy malnutrition. However, the practical aspects of frequent weighings of infants and children to monitor their growth and nutrition and to determine feeding pattern sequences need documentation and careful evaluation. Also required are development of communication techniques to insure that mothers understand growth, i.e., better comprehend the importance and meaning of weight gain and loss (e.g., weight chart, other means of "seeing" growth) and investigation of alternative monitoring technologies, e.g., Is arm circumference a simpler tool than weight or height?
f) The design and implementation of effective interventions (educational, food supplementation, etc.) have been hampered by lack of knowledge of determinants of intrahousehold distribution of foods in health and disease and specific ways the distribution of food negatively affects the small child. Closely related to this gap in knowledge are concurrent gaps in understanding factors that influence appetite, satiety, thirst, and anorexia in infants and children.

g) There are strong suggestions that "early bonding" may improve breastfeeding and promote health of infants (Sosa et al., 1976). The evidence, however, is not yet sufficient to dictate policies of infant and perinatal care in areas where early bonding is not routinely practiced. In this regard, and in general, maternal education has been shown to be inversely related to infant mortality (Behm and Primante, 1978). However, there is inadequate evidence to determine whether infant nutrition and health will improve if mothers are taught about early bonding or about such feeding practices as simple techniques for home-made preparation of complementary or weaning foods combined with general hygiene.
4. RECOMMENDATIONS

4.1 Recommendations for Research

The Subcommittee considers all the gaps in knowledge outlined in the preceding section to be important research priorities. From among those the Subcommittee has identified four issues of particular urgency and recommends that research required to address those issues receive highest priority. These four research priorities are listed below.

- Investigation of mechanisms, and implications for interventions, of the interaction between physical activity and (a) weight gain during pregnancy, (b) pregnancy outcome, and (c) lactation performance. This is a particularly important issue in areas where women routinely engage in labor-intensive activities. Specific research questions are posed in Section 3.1.2.b.

- Determination of causes of perinatal complications (including culturally determined practices), particularly in relation to stunting and other growth maturation alterations associated with previous and present nutritional status. Determination of the contribution of specific nutrient deficits, infection, and their possible synergism (or interaction) as a cause of perinatal complications and poor pregnancy outcome (prematurity, low birth weight). Specific questions are posed in Sections 3.1.1 and 3.1.2.1 and j.

- Selection and application of risk factors to identify communities, families, and persons at risk under different human ecologies (and
those who will benefit from intervention). Specific research questions are posed in Section 3.1.2.h.

- Development and evaluation of safe, feasible, and acceptable complementary feeding and weaning practices. This is discussed in Section 2.2 and specific questions are posed in Section 3.2.c.

The task of setting overall priorities for research in developing countries is complicated by the fact that demographic, sociocultural, economic, and general development characteristics and trends vary. Thus what may be a clear priority in one setting may be relatively unimportant in another. In addition, the opportunity to carry out pertinent research may influence the choice of priority topics and timing of their implementation. The human and operational resources available to accomplish what is considered of high priority are also important considerations. This last consideration is particularly important if the necessary studies are to be conducted in a developing country by, or at least in active collaboration with, local scientists and institutions. The Subcommittee considers that one essential component in such collaboration should be to strengthen the research and overall scientific capability of the host country as permitted by the project. When necessary, efforts should be undertaken to remove manpower and material constraints, e.g., by providing scientific training to insure adequate local expertise in selected research areas.

4.2 Recommendations for Intervention

Although epidemiologic data in developing countries are often not precise enough to estimate the prevalence of malnutrition, and evidence is
insufficient to understand precise biochemical or physiological mechanisms and adaptations involved in the pathogenesis of disease and malnutrition, the Subcommittee on the basis of this review and their collective experience is convinced that actions still can be taken within the broad context of health care that will improve the nutrition and health of women and young children in developing countries. Thus, this Section presents guidelines for interventions that reflect current knowledge and experiences in pertinent nutritional aspects of maternal and child populations. The general recommendations outlined in this section should form the basis of actions and should be modified as gaps in knowledge are removed and additional experience is gained.

4.2.1 General Guidelines

The Subcommittee recommends that nutrition and health interventions should form a single unit and be congruent with the general scheme of development for a target population. Unless very powerful operational obstacles exist, an intervention should have the following characteristics:

- The community should participate in its operation, with adequate technical input and supervision; (See Appendix C);
- The intervention should be aimed at the family;
- The intervention should be an integral part of a strategy of primary health care (as defined by WHO), which actually involves other sectors in addition to health (FNB, 1982);
- The intervention should integrate nutrition care with infection control and family planning;
- The intervention should be adapted to the prevailing local human ecological characteristics, including health care facilities, environmental conditions, cultural concepts, agricultural and food practices and beliefs, etc.

The aim should be that what begins as a well-designed intervention will eventually become a well-established community activity supported within the
community. Appendix C outlines suggested intervention activities of a well-run nutrition and health program.

The relative scarcity of resources, coupled with the concept that nutrition and health interventions should be directed to communities and families who most require them, immediately leads to a "risk approach". A risk approach involves selecting communities, families, or persons for intervention on the basis of characteristics associated with a higher probability of malnutrition and poor health. To implement such an approach effectively, valid, simple surveillance and survey methods adapted to local human ecological settings are essential.

If an intervention is community based, there are three alternatives: (i) to include the entire population; (ii) to include only families with one or more individuals at risk; or (iii) to include only individuals at risk. In every case a determination should be made of the severity and extent of risk in the community. The alternative selected depends, in principle, on existing characteristics, feasibility, cost-effectiveness, and type of operational systems which would insure maximum coverage of the target population.

The choice of the target population hinges upon the definition of communities, families, or individuals at risk who would benefit from a specific intervention, or from several interventions, in terms of improved health and reduction in specific risks related to reproduction and growth and development. In general it is preferable to consider the community and the family as the targets for intervention rather than only children under 5 years of age and pregnant and lactating women.

Based on the evidence reviewed in previous sections of this document, a number of factors are proposed as examples of criteria to define a family at risk. In some cases these criteria may also identify individuals or
communities at risk. These are suggested risk factors only. More methodological research is needed, using scaling techniques, for example, to determine the best combination of factors to identify those at risk.

Suggested "risk factors" include:

a) Previous reproductive failure and history of low birth weight deliveries

b) Low prepregnancy weight (and, in some cases, height)

c) Poor weight gain during pregnancy; inadequate mean monthly weight gain during pregnancy

d) Complications of pregnancy (bleeding, hypertension, urinary infections)

e) Pregnancy below 17 years of age

f) Presence of malnourished members in the family

g) Engagement of women and children in hard physical labor

h) Low socioeconomic status and little education of women

i) Poor parental experience, inadequate social support systems and negative feelings toward present pregnancy

j) Alcohol abuse

k) Smoking or smoke exposure (environmental conditions leading to hypoxia in mothers and children)

l) Family in a community where infant and early childhood mortality rates are above the median for the country or region

m) Community undergoing natural or man-made crisis or disasters (unemployment, drought, migration, war, etc.)

n) Poor system of preventive and curative health care

o) Limited availability of foods (in variety, quantity and quality; by season)

The following short sections provide additional guidelines on specific aspects of the recommendations.
4.2.2. **Actions Prior To and Between Pregnancies**

The Subcommittee agrees that the health and nutritional status of pregnant and lactating women must be monitored and, if necessary, improved. In addition, the Subcommittee suggests that the aim should be to insure optimal health and nutrition for women before as well as when they become pregnant and recommends adoption of actions to achieve this aim. For example, the social and economic rights of a woman and her participation as an active member of the family and the society should be considered in the design of interventions, as should her right to be well-nourished, healthy, and educated. Attainment of satisfactory nutritional status by changing intrahousehold food distribution practices so that women and young children obtain a fairer share should also be considered when planning interventions.

A special case is posed by societies where teenage pregnancies and high parities are common. Efforts should be made to provide adequate prenatal care and to bring teenagers into the system to receive such care. Where feasible, and particularly where prenatal care is limited, efforts should be made to delay the first pregnancy, ideally to about age 18 (e.g., through education programs which take cultural factors determining this practice into consideration). Such a delay in the age of the first pregnancy would bring women to pregnancy after full biological maturity is attained, would reduce the total number of pregnancies, and probably diminish obstetrical and nutritional risks. Thereafter, birth intervals of at least 18-24 months should maximize the opportunity to replenish maternal nutrient stores in women with chronic marginally adequate diets. Encouragement of breastfeeding and use of family planning programs should complement these desirable outcomes.
4.2.3. Actions During Pregnancy and Lactation

In principle, the earlier a pregnant woman enters a well-thought-out and implemented program of prenatal care, the better the outcome of pregnancy is likely to be. A program of pre- and perinatal care should be structured to make the best use of the facilities available and should be able to identify women at high nutritional or obstetrical risk using specific risk factors. In communities or populations where high risk is common, the feasibility of providing care to expectant mothers in specially organized centers for a period prior to delivery and in the perinatal period should be investigated. (This practice is being evaluated in several countries.)

Pregnancy and lactation are not the ideal periods to correct nutritional deficiencies, although in some settings this may be all that can be done at present. Thus, the Subcommittee recognizes that special nutritional supplementation programs are needed for nutritionally high risk pregnant women. As is the case for all food supplementation programs, such programs should be carefully conceived and should consider the long-term effects of the program for the pregnant woman, her family, and her community. Supplementation during pregnancy should be considered as a therapeutic action that attempts to avoid further nutritional deterioration and, if possible, corrects that already present. (As such it should have positive consequences for the fetus and the process of lactation later.) However, these short-term programs should not hamper nor detract from long-term interventions whose aim is to improve social and economic well-being, health status, food availability and food consumption (For example, See ACC/SCN, 1982). Rather, they should enhance these actions.

Special cases are those of nutrient fortification of foods and correction of specific deficiencies. These should be continuously operating programs whose implementation is determined at national or regional levels.
The perinatal period (prepartum, labor and delivery, and puerperium) is a critical period of maternal and infant health, the establishment of breastfeeding, and emotional bonding. Efforts to provide the best care possible within given cultural practices and available facilities and applying appropriate technology are of high priority to reduce maternal and infant perinatal complications and death. Thus, specific efforts during this period should be directed toward providing adequate perinatal care, encouraging breastfeeding, and establishing emotional bonding.

4.2.4 Actions Related to Infants and Young Children

a) Breastfeeding

Every effort should be made to support and encourage breastfeeding. In areas where breastfeeding has been abandoned as the universal mode of feeding, a return to breastfeeding should be promoted, and at the least, programs should be careful not to be conducive to further decline of breastfeeding.

b) Complementary Foods

Complementary foods should be introduced as early as necessary (to prevent growth faltering) and as late as possible (to favor continued breastfeeding and to protect from weanling diarrhea). Thus, measurement of incremental growth (growth monitoring) and efforts designed to reduce the threat of weanling diarrhea are of central importance.

There is considerable latitude in what constitutes a desirable complementary food and the following characteristics are merely general guidelines. Foods should be semi-solid so that they will not quench the thirst mechanisms, have a caloric density of not less than 50 kcal/100 grams, provide at least 10 percent of calories from protein, and about 20 to 30
percent of calories from fat. They should also be palatable for infants and not excessively high in fiber content. Examples are in Appendix B.

If suitable complementary foods are locally available, e.g., foods meeting the suggested criteria, their use should be encouraged. Where such foods are not locally available, efforts should be made to meet the criteria for a suitable complementary food by teaching about different preparation of foods from indigenous sources or by provision of foods from outside, so that preparation of foods with suitable composition is possible. Of course, development and introduction of appropriate complementary foods should be coupled with efforts to minimize their contamination.

If foods from outside are used they should be seen in the context of existing traditional feeding practices, provided such practices are not deleterious. In addition, distributed foods should be selected to supplement locally available foods, either by addition to or alternate feeding with traditional foods. Thus, distributed food "supplements" will usually need to be relatively high in protein and fat content and have high caloric density.

Milk and milk products are excellent sources of protein and minerals, but many nutritionists have reservations about administration of liquid milk to adequately breastfed infants because the milk competes with breastfeeding and may be improperly prepared. There also has been some concern about the use of milk because of possible lactose intolerance among recipients. However, the modest daily quantities of milk or its products needed to upgrade many traditional foods are well tolerated by individuals with limited lactose absorbing capacity (Brown et al., 1980; Torun et al., 1979). Therefore, milk and milk products should continue to play an important
role in feeding programs for infants and children, particularly as components of semi-solid foods. For very young infants under about two months who are not breastfed, a source of milk may be critical to survival where commercial formulas are unavailable.

c) Breast Milk Substitutes

Occasionally, a mother may be prevented from nursing because of illness or other compelling circumstances. Rarely, lactation simply fails. In these unusual cases (and when a substitute mother is unacceptable, impractical, or not available), homemade milk-based or commercial infant formulas can be a valuable and sometimes life-saving option. Formula should be used in a way that is not conducive to discontinuation of breastfeeding by women capable of and choosing to breastfeed. When breast milk substitutes are used, great care should be exerted in instruction regarding preparation of formula and cleaning of bottles and nipples. The latter should be used for feeding liquid substitutes only when use of cup and spoon is not feasible, and complementary foods, and usually even liquid substitutes, should be fed by spoon or cup.

d) Weanling Diarrhea

Prevention of diarrhea should begin with efforts to prevent malnutrition prior to the introduction of complementary foods so that an infant will have adequate nutritional reserves and intact host defenses when exposed to environmental pathogens associated with introduction of complementary foods. Breastfeeding is crucial in this regard. A second component of a prevention program should be education of the mother (and other caregivers) regarding modes of transmittal of diarrheal pathogens and appropriate personal hygiene and food preparation and storage techniques to
reduce transmission. The third component should include efforts to reduce exposure to pathogens from complementary foods and from other environmental sources. Such efforts could include environmental sanitation and development and utilization of appropriate intermediate technologies; emphasis should be placed on the proper use and storage of water when it is scarce.

If the diarrhea-malnutrition cycle is established, specific efforts should be undertaken to shorten the episodes and to break the cycle. Oral rehydration therapy is of central importance in these curative efforts (Rohde, 1983; Molla et al., 1982; FNB, 1981; Parker et al., 1980). Where available and necessary, specific therapy against pathogens responsible for the diarrhea and/or malabsorption should be provided. Depending upon the state of the child, specific actions should also include provision of suitable and palatable foods and efforts to overcome the anorexia and lethargy that commonly accompany the condition. A child who is nursing should be offered the breast and efforts should be made to maintain lactation during the diarrhea episode if the child refuses the breast. Whenever possible, breast milk and food intakes should allow catch-up growth (Rohde, 1978) and replenishment of nutritional deficits induced by diarrhea.

e) Growth Monitoring

The Subcommittee endorses frequent monitoring of growth in infants and young children as a means of detecting early nutritional deficits and poor health, thus allowing prompt remedial action. Therefore, the Subcommittee recommends that research to identify and eliminate operational constraints of growth monitoring receive high priority (See Section 3.2.e).
Appendix A. Effect of Lactation on Maternal Energy Balance, and Protein, Vitamin, and Mineral Status

Energy costs of lactation and maternal body composition

Milk production requires energy over and above the mother's own energy requirements, energy that must come from her food intake and/or her body stores. It is generally assumed that in women who have unrestricted access to food this energy will come from extra body fat stores accumulated during pregnancy. A slow but steady weight loss is therefore postulated to be a normal accompaniment to lactation (Thomson et al., 1970). In fact, reported rates of weight loss of presumably well-nourished lactating women in industrialized countries vary quite widely (Whitehead et al., 1981; Blackburn and Calloway, 1976; Naismith and Ritchie, 1975; Thomson et al., 1970). This variation is not surprising given wide variations reported for energy expenditure and intake. For example, mean reported calorie intakes of lactating women to range from 1600-2950 kilocalories per day (Whitehead et al., 1981; Sims, 1978; Blackburn and Calloway, 1976; Whichelow, 1976; Morse et al., 1975; Naismith and Ritchie, 1975; Pomon, 1974; Thomson et al., 1970; English and Hitchcock, 1968).

The extent to which a mother complements the breast milk her infant receives with other foods also may influence the rate of her weight loss (Manning-Dalton and Allen, 1983; Greiner et al., 1981). A recent study at the University of Connecticut on well-nourished women with adequate pregnancy weight gain found that women who were exclusively breastfeeding consumed more calories and lost less weight than women who used the greatest amount of complementary foods (Manning-Dalton and Allen, 1983). Other investigators have reported that "successful" breastfeedingers maintained high levels of
caloric intake and experienced little or no weight loss during the first four months postpartum (Clark et al., 1982; Roepke, 1982).

These studies suggest that much remains to be learned about the energy cost of lactation and weight loss specifically associated with lactation in well-nourished women. Furthermore, none of the studies of weight loss in well-nourished women have examined the composition of the loss, and few even contain data on skinfold thickness changes during lactation.

It is not yet possible to generalize about the relationship of energy intake to weight loss in women on marginal caloric diets in developing countries. Several careful studies suggest that specific local conditions determine how a woman will respond to the additional energy stress of lactation. Generally it appears that when high energy expenditure work-demands coincide with low food availability, weight loss occurs (Prentice et al., 1981, 1980; Prentice, 1980; Schutz et al., 1980). This tends to follow a seasonal pattern that is also characteristic of nonlactating women and men (Prentice et al., 1981, 1980; Prentice, 1980; Paul et al., 1979). For example, studies in the Gambia indicate that during the wet season when food is scarce and the work load is high, weight loss averages one kilogram per month (Prentice et al., 1981). In contrast, in the post-harvest dry season lactating women with average daily caloric intakes of 1600-1750 kilocalories actually gain weight, especially during early lactation (Prentice et al., 1981).

However, studies in New Guinea (Durnin, 1980; Harrison et al., 1975) and in India (Rajalakshmi, 1980) suggest that except under extremes of environmental pressure, weight loss in lactating women is less than one would predict from theoretical requirements and recorded intake (Durnin, 1980; Rajalakshmi, 1980; Harrison et al, 1975). Durnin (1980) hypothesizes that
maternal body weight is maintained at least partially because women have reduced their energy expenditure, but suggests that explication of the phenomenon will require careful studies of energy expenditure. Physiological adaptation to low energy intake (Prentice et al., 1981) and genetic adaptation in populations that have experienced many generations of energy deficit (Frisancho, 1981) also have been suggested as explanations. Neither of these has been systematically investigated.

**Protein Status and Lactation**

There have been very few studies in either well-nourished or poorly nourished women of protein metabolism during lactation. In a nitrogen balance study, King and colleagues (1973) demonstrated that nitrogen retention during the last trimester of pregnancy was more than twice the estimated deposition in the products of conception. From $^{40}\text{K}$ data, Pipe and colleagues (1979) calculated that nearly a kilogram of lean tissue is deposited during pregnancy, half of it in the breast. Whether this reserve is used during lactation has not been resolved.

Disturbances in protein status during lactation have been reported for Zaire (Vis and Hennart, 1978) and India (Gopalan, 1962; Belavady and Gopalan, 1960; Karmarkar et al., 1959; Belavady, 1959). In Zaire, where lactating women usually consume low protein diets, Vis and Hennart (1978) reported that malnourished women occasionally show kwashiorkor-like signs. The data from India are consistent with the interpretation that under conditions of low protein and low calorie intake, lean muscle is utilized to sustain lactation (Belavady, 1959; Belavady and Gopalan, 1960; Karmarkar et al., 1959). However, these data must be interpreted cautiously because of methodological problems.
In the Gambia, where the staple foods are higher in protein than in the area of Zaire studied by Vis and Hennart (1978), Whitehead and colleagues (unpublished manuscript) found no evidence of abnormal protein status during lactation. They did, however, find changes in amino acid patterns characteristic of pre-clinical kwashiorkor in pregnant women. This contrast between pregnancy and lactation is interpreted by them as consistent with the hypothesis that pregnancy places a greater strain on protein metabolism than does lactation. However, it is possible that inadequate intakes during lactation may be compensated by decreases in milk output, to the detriment of the infant.

**Vitamin Status and Lactation**

Very little is known about the effect of lactation on the vitamin status of women in developing countries. Information about status of fat soluble vitamins in lactating women in developing countries is virtually nonexistent. The major gap in knowledge, at least with regard to water soluble vitamins, is whether these vitamins are preferentially available to the mother or to the infant through breast milk. Some evidence from milk composition and supplementation studies in well-nourished women could be interpreted to indicate that, at least for vitamins $B_6$ and $B_{12}$, vitamin levels in milk are more directly affected by maternal vitamin intake than is maternal vitamin status (Sneed et al., 1981; Thomas et al., 1979; West and Kirksey, 1976). On the other hand, it has also been postulated that vitamin $B_{12}$ may be "trapped" in the mammary gland, thus making it preferentially available to the infant (Ford and Scott, 1963).

With respect to folate, several lines of evidence support the possibility that mothers with deficient folate intake are at a greater risk than are their infants.
1. Megaloblastic anemia is not uncommon in lactating women (Metz, 1970), while the incidence of megaloblastic anemia from folate deficiency in infants is apparently extremely rare (Tamura et al., 1980).

2. In two cases where lactating women with megaloblastic anemia were treated with oral folic acid, there were rapid increases in milk folate concentrations before hematologic responses occurred in the women (Metz et al., 1968).

3. In a Japanese study, women with normal plasma and red blood cell folate levels still had levels considerably below those found in their infants. In the infants, there was a significant correlation between plasma folate and breast milk folate level (Tamura et al., 1980).

Taken together these three points suggest that a regulatory mechanism exists to protect folate levels in human milk. If there is preferential utilization of folate for milk, the lactating woman may be at risk of deficiency.

In a set of careful studies in the Gambia, Bates and colleagues (1982, 1981) documented exceedingly low levels of riboflavin intake associated with clinical signs of riboflavin deficiency in lactating women. Initial supplements of 1 mg/day failed to produce any clear cut improvement in riboflavin status. Supplements of 2 mg/day given to lactating women, coupled with the average of 0.5 mg/day from dietary sources, resulted in satisfactory activation coefficients of erythrocyte glutathione reductase (an indicator of riboflavin status) in 90% of the women. Based on these results, the investigators suggest that current recommendations for riboflavin during lactation are too low.
In summary, in our judgment it is fair to conclude that current knowledge with respect to vitamin nutriture of lactating women is highly inadequate, and it is therefore very difficult to assess the effect of lactation on vitamin status of lactating women in developing countries.

Mineral Reserves and Lactation

With the exception of calcium, there appear to have been no studies relating mineral intake during lactation to the mineral status of the mother. Calcium is the one mineral for which there is a modicum of information. A woman with a milk output of 850 ml/day will excrete about 300 mg/day of calcium in her milk (Fomon, 1974). Under optimal conditions she is protected from depleting her own skeletal calcium by drawing on stores laid down during pregnancy (Pitkin, 1975). However, even with optimal dietary calcium intake, she will still lose some calcium from bone during lactation (Atkinson and West, 1970; Thomson and Black, 1970). These losses, however, do not appear to be cumulative. Walker's study of Bantu women suggests that following lactation and/or the next closely spaced pregnancy, the calcium loses may be recouped (Walker et al., 1972).

There may be protective mechanisms at work to buffer depletion of the mother's skeletal stores of calcium. It has been suggested that calcium absorption is increased under conditions of chronic calcium deficiency (Walker et al., 1972). Also, low protein diets, which are characteristic of some women in developing countries, may increase calcium retention (Allen, 1982). While short-term adaptive mechanisms may help protect mothers on low calcium diets, the effect of low calcium intake during repeated pregnancy-lactation cycles needs to be assessed, particularly in relation to calcium-related deficiency disease in later life.
Cases of osteomalacia occurring as a result of calcium loss during lactation are rare. Two studies report such consequences among Asian migrants to the United Kingdom (Fenton and Stone, 1966) and in Indonesia (Wolf, 1935). These, however, were probably caused by insufficient vitamin D and not by calcium deficiency. Other reports describing osteomalacia and tetany associated with lactation are confounded by additional factors (see, for example, Anderson and Brown, 1941). However, recent studies from the University of Utah (Slater and Thomas, 1982) suggest that adolescent mothers on calcium deficient diets may be at risk of calcium deficiency.

Iron is a mineral of particular concern given the high prevalence of anemia reported for women in developing countries. Recommendations for iron intake during lactation are usually theoretically set so that iron losses from pregnancy can be recuperated during lactation. However, there are virtually no empirical data on the functional effects of varying levels of iron intake during lactation on maternal nutritional status.
Appendix B: Examples of Complementary Foods

Foods Prepared at Home (from Cameron and Hofvander, 1976, pp. 132-155)

A. Wheat-based:
   - Wheat flour, brown 50g
   - Green gram 25g
   - Spinach (dark green leaves) 50g
   - Carrots 25g
   - Banana (skinned) 50g
   - Ghee (or vegetable oil) 5g
   - Milk (buffalo) 50g

1. Prepare a dough with the flour, a little salt, and water. Bake into 2 small chapattis. Add the ghee and serve hot.
2. Clean and wash the green gram; cook in a little water until soft, with salt, a pinch of turmeric, and cumin seeds.
3. Wash and chop the spinach and add to the green gram. Continue cooking until the spinach is soft. The mixture should be semisolid and well blended when served. Some of the ghee can be used to fry the spices and add to the cooked beans.
4. Serve the milk as a drink.

   (India, 430 kcal)

B. Rice-Based:

   a. Rice 40g
      - Groundnuts 10g
      - Cowpeas 20g

1. Roast groundnuts lightly, remove and discard skins, and grind nuts to a smooth paste.
2. Soak cowpeas overnight, remove testa and eyes, and cook gently in water until soft.
3. Add the groundnut paste to cooked cowpeas and mix well.

4. Wash the rice thoroughly. Cook in the usual way.

4. Serve cowpea mixture with rice, beaten smoothly together, if necessary.

C. Sorghum-based:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum flour</td>
<td>35g</td>
</tr>
<tr>
<td>Field-pea flour</td>
<td>10g</td>
</tr>
<tr>
<td>Fenugreek (soaked overnight)</td>
<td>5g</td>
</tr>
<tr>
<td>Oil</td>
<td>5g</td>
</tr>
<tr>
<td>Sugar</td>
<td>5g</td>
</tr>
</tbody>
</table>

1. Mix sorghum, pea flour, and soaked fenugreek with water.

2. Bring to a boil, stirring frequently.

3. Add oil and sugar.

4. Cook gently for 15 minutes. Add salt to taste.

   (Ethiopia, 295 kcal)

D. Maize-based:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize meal</td>
<td>65g (1 Arabian coffee cup)</td>
</tr>
<tr>
<td>Egg</td>
<td>25g (1 small egg)</td>
</tr>
<tr>
<td>Sugar</td>
<td>10g (1 heaped tspn)</td>
</tr>
<tr>
<td>Oil</td>
<td>5g (1 heaped tspn)</td>
</tr>
<tr>
<td>Water to cook</td>
<td></td>
</tr>
</tbody>
</table>

1. Mix meal to a paste with a little cold water.

2. Bring the rest of the water to a boil.

3. Add the maize-meal paste and stir until cooked and thickened.

4. Remove from the fire.

5. Add the egg.

6. Beat well until creamy.

7. Feed to the infant from a spoon.

   (350 Kcal)
E. Potato-based:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato, edible portion</td>
<td>200g (2 large potatoes)</td>
</tr>
<tr>
<td>Chick-pea flour</td>
<td>30g (1 small sini)</td>
</tr>
<tr>
<td>Kale</td>
<td>40g (about 5 leaves)</td>
</tr>
<tr>
<td>Oil</td>
<td>5g (1 tspn)</td>
</tr>
</tbody>
</table>

1. Peel potato and cut in pieces. Add mashed, coarsely chopped kale on top.
2. Boil in water until potato is soft.
3. Drain off water and use to cook the chick-pea flour.
4. Mash the potato and kale finely.
5. Add to the chick-pea mixture with more water, if necessary.
6. Add salt to taste and simmer until mixture is smooth and soft.

(Ethiopia, 325 kcal)

F. Yam-based:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yam, edible portion</td>
<td>240g</td>
</tr>
<tr>
<td>Powdered fish</td>
<td>15g (1 tbspn)</td>
</tr>
<tr>
<td>Palm oil, red</td>
<td>10g (2 tspn)</td>
</tr>
<tr>
<td>Water to cook</td>
<td></td>
</tr>
</tbody>
</table>

1. Put small pieces of peeled and cut-up yam into a pot and just cover with water.
2. Bring to a boil and add the powdered fish.
3. Cook gently until yam is soft.
4. Remove any surplus water.
5. Mash yam and beat in the oil.
6. Feed the infant from a spoon.

(315 kcal)
Commercially Prepared Foods (from Cameron and Hofvander, 1976, pp 105-106).

1. Staple cereal plus vegetable protein concentrate, e.g., cottonseed flour. An example is Incaparina, developed in Guatemala.

2. Wheat plus high percent precooked peas and lentils. An example is Superamine, produced in Algeria (also contains 10 percent skimmed-milk powder).

3. Cereal (wheat) plus legume (chickpeas) with addition of vegetable-protein concentrate (soy flour) and 5 percent dried skimmed milk. An example is Faffa, mas in Ethiopia.

Vitamins and minerals are usually added to these products. They all have more than 20 percent protein, but because the energy value is usually low in relation to protein concentration, some sugar and/or fat must be added when the product is prepared for use.
Appendix C: Activities Essential in Health and Nutrition Programs

The following activities are suggested as essential or highly desirable components of a well-run nutrition and health program in developing countries. The discipline or sector with primary responsibility for implementation of each activity is also indicated. As the outline indicates, a number of activities have conventionally been considered the primary responsibility of one, or at most two, sectors. It is most probable that an effective and long-lasting implementation of these activities requires an integrated multidisciplinary effort and a willingness to cooperate across disciplines.

<table>
<thead>
<tr>
<th>Actions Prior To and Between Pregnancies and Lactation</th>
<th>Primary Responsibility</th>
<th>Other Disciplines*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Health</td>
<td>Nutrition</td>
</tr>
<tr>
<td>1. Improve nutrition and health in childhood and adolescence</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2. Delay first pregnancy</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3. Family planning</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>4. Improve social support systems for family members, with emphasis on upgrading the social and economic value of women and children</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>5. Health and nutrition education to family and mothers in particular</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>6. Undertake provisions necessary to insure adequate food availability and intake with emphasis on mothers and children, including increased earnings and improved spending patterns by families</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

* E.g., Communication Sciences, Education, Community Development
<table>
<thead>
<tr>
<th>Actions During Pregnancy and Lactation</th>
<th>Primary Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Health</td>
</tr>
<tr>
<td>1. Assure at least a minimal level of prenatal care -- use risk approach; treat intercurrent infections</td>
<td>x</td>
</tr>
<tr>
<td>2. Tetanus immunization</td>
<td>x</td>
</tr>
<tr>
<td>3. Assure adequate weight gain during pregnancy, especially among thin and young women. If necessary, supplement nutrient intake in 3rd trimester, ideally earlier</td>
<td>x</td>
</tr>
<tr>
<td>4. Prevent specific nutrient deficiencies (iodine, iron, folate, vitamin A)</td>
<td>x</td>
</tr>
<tr>
<td>5. Provide best available perinatal care (institutional or home-delivery assisted by trained attendant)</td>
<td>x</td>
</tr>
<tr>
<td>6. Early bonding, when possible</td>
<td>x</td>
</tr>
<tr>
<td>7. Monitor puerperium for infections and complications</td>
<td>x</td>
</tr>
<tr>
<td>8. Prepare for breastfeeding (include whole family) and assure best conditions for this function</td>
<td>x</td>
</tr>
<tr>
<td>9. Sex education and family planning</td>
<td>x</td>
</tr>
<tr>
<td>Actions Directed to the Infant and Young Child</td>
<td>Primary Responsibility</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><strong>1. Breastfeeding</strong></td>
<td>Health: x</td>
</tr>
<tr>
<td><strong>2. Monitor growth and development and health status, with emphasis on diarrhea prevention, through community surveillance; institute supplementary feeding to undernourished children; and maintain an early oral rehydration program.</strong></td>
<td>Health: x</td>
</tr>
<tr>
<td><strong>3. Treat infections. Diarrhea and respiratory infections are a real problem. Oral rehydration is essential.</strong></td>
<td>Health: x</td>
</tr>
<tr>
<td><strong>4. Introduce semi-solid complementary foods as soon as weight gain declines from accepted norms for each child and no later than 6 months, while preserving breastfeeding.</strong></td>
<td>Health: x</td>
</tr>
<tr>
<td><strong>5. Train family and especially mothers in preparation of complementary foods for infants (nutrition, hygienic practices)</strong></td>
<td>Health: x</td>
</tr>
<tr>
<td><strong>6. Recognize lactation failure and institute necessary infant feeding practices based on milk or milk substitutes</strong></td>
<td>Health: x</td>
</tr>
<tr>
<td><strong>7. Nutrition and health education with emphasis on the process of weaning and on weanling diarrhea. Insist on young children's progressive participation in sharing of family food and on continued or early and adequate intake during and after diarrhea.</strong></td>
<td>Health: x</td>
</tr>
</tbody>
</table>
8. Ascertain that an effective immunization program is operating.

9. Whenever possible, establish programs of early stimulation* at the community level.

*Early stimulation is recognized as highly desirable, particularly among communities where social and economic deprivation hampers intellectual, emotional, and motor development in infants and young children. Thus, efforts to encourage early stimulation, for example to develop new motor or conceptual skills, should be an integral part of community efforts in health and nutrition.
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