

A Reconceptualization of the Effects of Undernutrition on Children's Biological, Psychosocial, and Behavioral Development

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Introduction

About 40%—approximately 190 million—of the world's children below 5 years of age are underweight (that is, weight-for-age two standard deviations below the medians of the National Center for Health Statistics of the United States [NCHS]/World Health Organization [WHO])¹ and may, according to international organizations such as WHO, be assumed to be suffering from or to have suffered from varying degrees of undernutrition (International Conference on Nutrition, 1992). The numbers are particularly high in southern Asia and are increasing in Africa, especially sub-Saharan Africa. Severe clinical undernutrition, much less common than mild-to-moderate undernutrition, affects up to 10% of preschool children, depending on the country surveyed.

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In many of these societies, chronic under-nutrition during infancy and early childhood has significant adverse effects on subsequent cognitive development and school performance. Ultimately, a high prevalence of under-nutrition stands to interfere with the formation of human capital, the cornerstone of social and economic development and welfare within a society.

In 1973 a subcommittee on Nutrition, Brain Development and Behavior of the Committee on International Nutrition Programs of the Food and Nutrition Board of the National Academy of Sciences (NAS) of the United States published a position paper on the relationship of nutrition to brain and cognitive development (NAS, 1973). This paper reported that although the fundamental mechanisms by which nutritional and environmental factors may affect the central nervous system were not known, three putative pathways for causal action were recognized:

- (1) Structural and biochemical changes in the brain may alter brain function and reduce learning abilities.
- (2) These factors may decrease exposure and responsiveness to environmental stimuli and thereby limit development.
- (3) Changes in personality, emotionality, and behavior of the child may disrupt the learning process.

The authors added, however, that there was no evidence to claim that undernutrition “per se contributes more or less to the depressed cognitive development of previously malnourished children than do unfortunate social and environmental conditions” (1973, p. 4). Evidence did suggest, nevertheless, that severe undernutrition does impair intellectual development, above and beyond the effects of social influences. Since then, a number of reviews have been published by independent investigators who considered available evidence in the context of the mechanisms postulated by the NAS position paper (Barrett & Frank, 1987; Buzina et al., 1989; Levitsky,

1979; Lozoff, 1988; Pollitt, 1987, 1988; Pollitt & Thomson, 1977; Simeon & Grantham-McGregor, 1990). Overall these reviewers concurred that severe malnutrition in early life impairs cognitive function, but they considered the evidence on mild-to-moderate malnutrition insufficient for definitive conclusions.

New information on undernutrition has recently led to a reconceptualization of its effects on human development. Combined with results of new experiments using animal models (Almeida, Oliveira, & Graeff, 1991; Austin et al., 1992; Bedi, 1992; Diaz-Cintra, Cintra, Ortega, Kemper, & Morgane, 1990; Keller, Cuadra, Molina, & Orsingher, 1990; Medvedev & Babichenko, 1988), new evidence is emerging from a variety of studies in human populations:

- (1) Clinical trials of dietary (Husaini et al., 1991) and iron (Lozoff, 1990) supplementation;
- (2) Follow-up assessments of previously severely malnourished (Grantham-McGregor, Powell, Walker, Chang, & Fletcher, 1994) and supplemented (Pollitt, Gorman, Engle, Martorell, & Rivera, 1993) children;
- (3) Studies of specific nutrients and contextual risk factors as predictors of functional competence at different ages (McCullough et al., 1990; Sigman, Neumann, Baksh, Bwibo, & McDonald, 1989; Wachs et al., 1995).

Whereas researchers previously focused on protein energy malnutrition (PEM) as a central causal agent, they have become increasingly aware that such an approach is limited because PEM is not a distinct clinical entity but a syndrome having multiple causes (Schürch, 1995). PEM coexists with micronutrient deficiencies and imbalances that can affect central nervous system (CNS) function and divert development from a normal trajectory (Golub, Keen, Gershwin, & Hendrickx, 1995; Pollitt, 1995). But the social environmental context also plays a key role.

Investigators have thus shifted away from measuring the contribution of undernutrition to cognitive deficits, *per se*, toward identifying and measuring the interactions and transactions among undernutrition and contextual factors that determine the final outcome of the undernourished child. Mild-to-moderate malnutrition is now recognized as indeed a developmental risk factor. Conjointly, stunted brain growth is considered too simple an explanation in light of recent evidence, so that other biological mediators, such as alterations in neuroreceptor sensitivity, are now being considered (Levitsky & Strupp, 1995; Strupp & Levitsky, 1995).

These new scientific developments led the International Dietary Energy Consultative Group (IDECG) to convene a task force² to assess current knowledge of the relationship between undernutrition and behavioral development in children and to interpret this information in the context of current theories of nutrition and developmental psychobiology. The Task Force, consisting of nutritionists, physiologists, physicians, and psychologists, presents in this report a review and interpretation of the main findings currently available on the effects of several types of undernutrition. Also included are new perspectives on undernutrition which point to a theoretical reconceptualization of the issues.

Reconceptualizing the Relationship of Nutrition and Development

The following section describes how the strategy for investigating the relationship between undernutrition and cognitive development has changed and is continuing to evolve. Also discussed are some of the problems in defining the nutritional and outcome variables of interest and how biological and environmental factors can modify the effects of undernutrition.

Assessing Nutrition

Protein and energy. In the 1960s, when researchers and policymakers were becoming increasingly concerned that early PEM could result in permanent impairment of intellectual development, it was widely accepted that protein was the limiting nutrient in the diet of populations at risk. During the next decade, however, dietary energy was held to be the more critical factor (McLaren, 1974). It was understood that to provide undernourished children with protein without also providing sufficient energy was futile, because the dietary protein would be used to supply energy rather than essential amino acids.

Iron, iodine, and zinc. Accompanying the new focus on energy was a recognition that, in most circumstances, energy deficiency may be closely linked to political and socioeconomic problems not easily addressed by simple nutritional intervention. Such political complexity and the fact that dietary energy is inextricably confounded with a mix of nutrients were two of numerous reasons that led subsequent research and policy interest to shift from the study of PEM effects to the effects of specific nutrients, especially Vitamin A, iron, iodine, and zinc. Whereas iron deficiency was known to be a cause of anemia, zinc deficiency a cause of growth retardation, and iodine deficiency a cause of goiter and cretinism, studies established further that deficiencies in these nutrients have broader systemic effects that lead to multiple threats to child health and development (United Nations ACC/SCN, 1993).

Complexities of deficiencies. Mild-to-moderate protein-energy malnutrition is difficult to diagnose, because it does not produce a specific set of symptoms and signs. It also coexists with other nutrient deficiencies. The same foods, particularly those from animal origin (from meat, fish, and poultry), are often sources of energy, protein, and distinct micronutrients (e.g., iron and zinc). Children

that do not have access to these foods are at risk of multiple nutritional deficiencies. Further, some constituents of a habitual diet can limit the absorption of some important nutrients. This is the case, for example, with phytates, tea, and coffee which inhibit the absorption of non-hemic iron. Dietary quality² is critically important, requiring diversity and, to the extent possible for a family, the inclusion of foods of animal origin.

Where food is scarce and dietary quality is poor, diets consist primarily of staples such as cereals and legumes. Such diets typically contain few animal products, fresh fruits, or vegetables, and are therefore associated with low intakes of certain vitamins and minerals, high intakes of phytates and fiber, and poor bioavailability³ (Allen, 1993). Moreover, bioavailability is reduced when the supply of nutrients that enhance absorption is low. Finally, when food availability and quality are inadequate, the incidence of morbidity is usually high, with several nutrients simultaneously depleted through anorexia, malabsorption, and/or diarrhea with its associated inflammatory responses (Chen, 1983; Martorell & Yarbrough, 1983; Sahni & Chandra, 1983).

Thus, with both the nature of nutritional deficiency and the relationship among nutrients unclear, it remains a challenge not only to understand effects but to utilize findings in designing intervention strategies. In populations where general undernutrition is common, supplementation with a single nutrient, with the exception perhaps of iodine, will often be ineffective because as one deficiency is ameliorated, others may become limiting.

Measuring Outcome

Investigations of both the nature and range of effects of undernutrition on intellectual development have been limited by the restricted nature of the psychological tests commonly used to assess children's cognitive

development. Availability and convenience of the test seem to have been the dominant criteria for test selection, rather than considered theory and well-defined hypotheses that would test the psychological processes most likely to be affected. Consequently, it is possible that deficits in specific cognitive functions, e.g., attention, have not been adequately assessed by IQ or achievement tests, and may have been underestimated or missed entirely (Diamond et al., 1992). This concern is borne out by suggestive evidence of impaired attentiveness in previously undernourished children (Galler, Ramsey, Solimano, & Lowell, 1983).

Effects of undernutrition on social and emotional development have been generally disregarded. The few researchers who have investigated such effects have observed that social and emotional development is sensitive to undernutrition (Barrett, 1984; Espinosa, Sigman, Neumann, Bwibo, & McDonald, 1992) and can moderate effects on other processes. Detriments in these domains, observed repeatedly in animal studies (Levitsky & Strupp, 1995), may well have significant effects on the child's ability to adapt to the educational and social environment.

The traditional approach of focusing exclusively on cognitive development, independent of other psychological processes and systems, contradicts both current understanding of psychological development and the results of experimental studies based on animal models. Such a restricted approach also gives the mistaken impression that the effects of undernutrition on cognition are direct. Current data indicate strong reciprocal interactions between cognitive and emotional development so that changes in one may contribute to changes in the other (Rothbart, Derryberry, & Posner, 1994; Steinmetz, 1994).

Incorporating the Context

Adopting a contextual approach acknowledges that we can not interpret the contribu-

tions of specific biological or psychosocial factors to development independent of the individual's specific environment. Within this framework, the study of nutritional influences on development must account for not just the biological but also the psychosocial stressors that accompany undernutrition (Horowitz, 1989; Pollitt, 1987; Ricciuti, 1981, 1993). Available evidence clearly demonstrates that undernourished individuals have a higher probability of simultaneous exposure to other risk factors (Golden, 1991; Grantham-McGregor, 1984; Pollitt, 1987), including

- (1) *biological factors* (e.g., morbidity, parasitic infection, lead exposure);
- (2) *psychosocial factors* (e.g., child neglect, poor-quality schools);
- (3) *socioeconomic factors* (e.g., parental underemployment, lack of access to medical care).

Conversely, the detrimental impact of an adversity may be attenuated (though not necessarily eliminated) by *protective factors*, such as maternal education (Rutter, 1983; Zimmerman & Arunkumar, 1994). For example, in one study among impoverished rural communities in Guatemala, maternal education ensured that the children benefited from a nutrition program. Independent of the distance between home and the center where the foods were distributed, the mothers with higher levels of education took the children to the center to eat the food distributed without charge. This was not the case among children of mothers with low levels of education: these children were likely to be taken to the center only if they lived nearby (Carmichael, Pollitt, Gorman, & Martorell, 1994).

Traditionally, environmental influences have been regarded as complicating nuisances, to be controlled for by elements of the research design or statistical procedures. But this view has tended to oversimplify or obscure inherent complexities of causation that can only be captured if the most relevant biological, psychosocial, and socioeconomic factors (the covari-

ates) are an integral part of the research plan (Lozoff, 1990).

Main Research Findings

The following is not intended to be a comprehensive review of the literature. Rather, it is restricted to what members of the Task Force held to be the main and strongest findings. More extensive reviews are provided in papers prepared by Task Force members and published in the *Journal of Nutrition Supplement*, "The Relationship between Undernutrition and Behavioral Development in Children," (volume 125, number 8S). This present review focuses first on data from observational and intervention studies of intrauterine growth retardation and PEM and then describes findings from intervention studies of micronutrient deficiencies.

Intrauterine Growth Retardation

Three strategies have been used to test the effects of mild-to-moderate prenatal undernutrition on behavioral and cognitive development:

- (1) Assess the development of growth-retarded newborns.
- (2) Follow children born into periods of famine.
- (3) Track the effects of supplementing the diet of nutritionally at-risk mothers on the development of the offspring.

Development of growth-retarded newborns. This is a very heterogeneous group. Although social class is the strongest predictor of intrauterine growth retardation, other factors, including genetics, infection, placental damage, and maternal malnutrition, may also cause growth retardation (Kramer, 1987). This report focuses exclusively on those relatively few studies that investigate nutritional factors. In Guatemala, for example, one study found that birth weight below the 10th percentile of

the reference weight distribution for gestational age was associated with cognitive delays at 36 and 48 months (Gorman & Pollitt, 1992; Villar, Smeriglio, Martorell, Brown, & Klein, 1984), but birth weight was unrelated to cognitive test performance at 60 months and in adolescence (Pollitt, Gorman, & Metallinos-Katsaras, 1992).

Studies in more affluent countries suggest that the timing of malnutrition can moderate the outcome (Wachs, 1995). Comparatively poor postnatal performance deficits were more likely when prenatal stunting occurred before 24 weeks of gestation (Harvey, Princie, Burton, Parkison, & Campbell, 1982). But other social, educational, and biological factors can also moderate the effects of prenatal undernutrition. As noted by Wachs (1995), postnatal developmental risk is decreased among infants from socially and economically advantaged families (Vohr, Garcia-Coll, & Oh, 1989); they **tend** to have fewer postnatal biomedical complications (Eckerman, Sturm, & Gross, 1985) and **are** more likely to be exposed to programs of early cognitive stimulation (Padin-Rojas et al., 1991).

Children of famine. Children born to Dutch women whose second half of pregnancy coincided with the famine in the winter of 1944–45 had an average birth weight 327 grams below the norm. In early adulthood, however, they showed no deficits in intelligence (Stein, Susser, Saenger, & Marolla, 1975).

In Kenya, a period of drought and food shortage compromised further the energy intake of families among a nutritionally at-risk population. Besides showing weight loss, school children became less attentive in the classroom and reduced their motor activity in the playground. Toddlers were protected through family adjustments: Neither their energy intake nor their body weight was reduced; play and language behavior also remained stable (McDonald, Sigman, Espinosa, & Neumann, 1994).

Nutritional supplementation of mothers. Supplementation trials of pregnant women have yielded mixed findings. One study in Harlem, New York, found no effects of protein supplementation during pregnancy on the performance of offspring on developmental tests administered at 12 months of age, but the subjects did show beneficial effects on measures of habituation and play behavior (Rush, Stein, & Susser, 1980). A second study in Sui Lin Township, Taiwan, found sparse effects: infants at 8 months of age whose mothers had received a protein and energy supplement during pregnancy and lactation showed no effects on mental development and modest beneficial effects on motor development (Joos, Pollitt, Mueller, & Albright, 1983). At 5 years of age the children's performance on an IQ test showed no effects of the supplement (Hsueh & Meyer, 1981).

In summary, empirical evidence favoring the assumption that intrauterine growth retardation causes cognitive delays is weak. The number of relevant studies is small, and the data are not supportive, particularly in studies of middle childhood and adolescence. Further, a recent review of studies of children 7 years old and older, conducted in the United States and Europe, found little to support that intrauterine growth retardation is a risk factor for later development (Hack, 1996).

Concurrent and Later Effects of Undernutrition

Two sets of data are cited in this section: The first includes observational studies that tested the relationship between anthropometry (human body measurement) and dietary intake, on the one hand, and performance on mental and motor tests, on the other. In some of the studies the nutritional and outcome measures were concurrent; in others the anthropometric and dietary measures preceded the outcome measures. The second set of data comes from studies in which subjects' daily

dietary intake was controlled, amounting to a nutritional supplement.

Body size, diet, and development. Measurements of linear growth (i.e., recumbent length and height), body weight, and other anthropometric measurements (e.g., skin-fold thickness) are widely used in clinical work and nutrition epidemiology to classify the nutritional status of children from infancy to adolescence. Children whose growth is slow or arrested in populations where malnutrition is endemic are assumed to be or to have been undernourished. In this light it would seem reasonable to postulate that an association between poor physical growth (e.g., stunting) and slow mental development was explained primarily by nutritional factors. That is, if undernutrition explained children's physical growth retardation, and retardation was associated with slow mental development, then undernutrition must also explain delays in mental development. This interpretation is speculative, however: both physical growth in early and late childhood and cognitive development are influenced by many other factors besides nutrition.

Independent of prenatal nutritional history, chronic mild-to-moderate PEM during the first 2 years of life has frequently, but not always, been found related to concurrent delays of mental and motor development (Wachs, 1995). In one study of young children in Jamaica, stunting was associated with reduced motor activity and exploratory behavior (Simeon & Grantham-McGregor, 1990). Later, again in Jamaica, better-nourished children exhibited increases in exploratory behavior and social interaction (Meeks Gardner et al., 1993). A study in West Java, Indonesia, found an association between body length and delays in the acquisition of gross motor milestones leading to bipedal locomotion (Pollitt et al., 1994). Self-locomotion is presently considered a critical experience for normal cognitive development (Bertenthal & Campos, 1990).

While undernutrition of infants is a concern, undernutrition among preschoolers and school-age children is also a serious public health problem. Undernourished preschool children accustomed to diets that do not meet their physiological requirements are at risk for lower levels of attention, learning impairment, and poor school attendance and achievement (Simeon & Grantham-McGregor, 1990; Wachs, 1995). A study in Kenya, for example, found that, after taking demographic factors into account, energy and animal protein intakes during the preschool years were associated with play and cognitive performance at 5 years of age (Sigman, McDonald, Neumann, & Bwibo, 1991). Other evidence from school-age children indicated that body size, particularly height-for-age, was related to performance on cognitive and achievement tests (Wachs, 1995).

Anthropometric indicators of undernutrition during the first 3 years of life also predict cognitive test performance in later childhood and adolescence. In the same study in Kenya, body size in infancy predicted performance on cognitive tests administered at 5 years of age (Sigman, Neumann, Janson, & Bwibo, 1989). Rural Guatemalan subjects also showed an association between height at 3 years of age and performance on a battery of psycho-educational tests administered 15 years later (Martorell, Rivera, Kaplowitz, & Pollitt, 1992).

Regarding diet, studies in Egypt (Wachs et al., 1995) and Kenya (Sigman, Neumann, Baksh, et al., 1989) showed that among toddlers intake of energy and total protein were positively associated with level of symbolic play and mental competence. In the Kenyan study, animal protein intake, compared to total protein, assessed at 18 and 30 months of age, was the better predictor of cognitive test performance at 5 years of age (Sigman et al., 1991).

Cognitive test performance among school children was also related to the quantity and

quality of the diet. For example, the total energy and protein intakes of school-age children in Kenya were positively related to cognitive development (Sigman, Neumann, Janson, et al., 1989). However, in Kenya, as in Egypt, the intake of a better-quality protein (from animal sources) was a better predictor of performance in this age group (Wachs et al., 1995).

Protein and energy malnutrition. Laboratory animals which are severely undernourished early in life show a wide range of changes in responsiveness to environmental contingencies (Strupp & Levitsky, 1995). The most pervasive and permanent changes appear to be in emotionality, motivation, and anxiety level, which in turn affect all aspects of behavior, including those indicative of cognitive status. Affective changes that seem to be associated with changes in neural receptor functions and lowered cognitive flexibility persist after rehabilitation (Strupp & Levitsky, 1995).

Severely undernourished children are apathetic, not very responsive to their environment and inclined to stay close to their mother (Grantham-McGregor, 1995). Some of these behavioral characteristics persist into early childhood. For example, in a study in Barbados school-age children who were severely undernourished as infants were characterized as quiet, withdrawn, and passive (Galler et al., 1983). Severe undernutrition in early childhood was also associated with later cognitive deficits and poor school achievement in a study of children in Jamaica (Grantham-McGregor, 1995), particularly for children who continue to live under conditions that are not supportive of their growth and development. The early placement of such children in environments where they receive good nutrition, psychosocial support, and education can substantially reduce or even eliminate cognitive deficits (Colombo, de la Parra, & Lopez, 1992; Grantham-McGregor, Powell, Walker, & Himes, 1991; Winick, Meyer, & Harris, 1975).

Supplementary feeding. A meta-analysis of experimental and quasi-experimental studies

showed that supplementary feeding during pregnancy and the child's first months of postnatal life enhanced motor development among infants (8 to 12 months) and toddlers (12 to 24 months) and also mental development among toddlers (Pollitt & Oh, 1994). In a study in Mexico early supplementary feeding influenced the quality of the mother's caregiving behavior (Chavez & Martinez, 1984). A relationship between the child's diet and maternal behavior was also observed in a study in Egypt, even after statistically controlling for the adequacy of the mother's own dietary intake (Wachs et al., 1992). These findings illustrate the influence that nutrition has on the reciprocal relationship between parent and child—the parent's caregiving practices influencing infant development and the infant's behaviors influencing parent's caregiving practices.

Supplementary feeding during the first 2 years of life has also been found to have long-term effects on cognitive development. In rural Guatemala, nutritional supplementation of pregnant and lactating women and their offspring for at least the first 2 years of postnatal life improved the later performance, in adolescence, on tests of reading, vocabulary, arithmetic, and general knowledge. Effects were strongest among children whose families were at the low end of the social and economic distribution within their rural communities (Pollitt et al., 1993).

Evidence suggests further that supplementary feeding beyond the period of peak growth of the central nervous system has long-term effects on cognitive development. In the Guatemalan study, supplementary feeding after the first 2 years of life also led to improved performance, in adolescence, on tests of arithmetic, general knowledge, and reading (Pollitt et al., 1993). In one intervention in Cali, Colombia, which began at 42 months of age or later and combined nutritional supplementation (protein, energy, and vitamins A and B plus iron) with health support and educational stimulation, undernourished preschool children

showed improved cognitive test performance. At the beginning of primary school, however, when the intervention was discontinued, the amount of benefit children showed varied, depending on the timing and duration of support: the earlier the intervention was begun and the longer it lasted, the greater the benefit (McKay, Sinisterra, McKay, Gomez, & Lloreda, 1978).

Theoretically, school nutrition should enhance children's achievement by improving attendance, preventing hunger, and correcting nutritional deficiencies. Evaluations of school nutritional programs have yielded equivocal results overall; however, in those with stronger research designs (i.e., in Jamaica, Peru, and the United States) the expected effects were observed (Jacoby, Cueto, & Pollitt, 1996; Meyers, Sampson, Weitzman, Rogers, & Kayne, 1989; Pollitt, Jacoby, & Cueto, 1996; Powell, Grantham-McGregor, & Elaston, 1983).

Contextual Factors

Assuring the best prediction of an undernourished child's later development requires that we account for not only the nutritional risk but also the context in which malnourishment occurred (Wachs, 1995). Undernutrition, with few exceptions, is closely associated with economic impoverishment, limited educational opportunity, limited access to health care, poor hygiene and sanitation, and continuous exposure to vectors of infection (Mata, 1978). But even where such conditions prevail, those families that are socially and economically better off are less likely to house an undernourished child (Espinosa et al., 1992; Grantham-McGregor, 1984; Kirksey et al., 1991; Wachs et al., 1995). Contextual conditions also explain, by themselves or through their interaction with malnutrition, part of the retarded physical growth and the delays in motor, mental, and socio-emotional development of undernourished infants and children. Further, in more affluent countries, young

children who are undernourished owing to medical reasons are generally free of any cognitive deficits (Pollitt, 1987).

An interaction between socioeconomic background and early supplementary feeding was observed in Guatemala. As noted earlier, the effectiveness of an early energy and protein supplement on later performance in adolescence was greatest for those children who were at the lowest end of the social and economic distribution (Pollitt et al., 1993). The supplement appeared to compensate for low status.

In summary, nutritional indicators (e.g., anthropometry and dietary intake) among infants and preschool children are positively related to performance on tests of mental and motor development. Anthropometry (particularly height-for-age) also relates to school-age children's performance on cognitive and psycho-educational tests. Supplementary feeding during pregnancy and during the first 2 years of postnatal life enhances the development of nutritionally at-risk children and improves cognitive competence as measured 10 years later. Some of these benefits result even if the intervention started after the peak period of central nervous system growth. Nutritional factors, however, do not fully explain delays in development or the comparatively poor test performance of undernourished children. Contextual factors, rooted in poverty, must be invoked. Assessing the combination of these factors and nutritional risk yields the best prediction of the development of these children.

Micronutrient Deficiencies

As noted earlier, some micronutrient deficiencies that coexist with protein and energy deficiency have adverse effects on behavior in laboratory animals, on mental and motor development of infants and toddlers, and on the cognitive functioning of older children. It is important that we not overlook the role of micronutrient deficiencies in studies of the effects of undernourishment on child develop-

ment. In some investigations such deficiencies are a confound; in others they can be conceptualized as an effect modifier. In the first instance, the dietary intake of children in populations previously considered at risk of PEM were likely to have been deficient in vitamins and minerals, *not* in energy and protein, thus confounding results (Allen, 1993; Beaton, Calloway, & Murphy, 1992). In the second, nutritional factors that cause PEM could also be causing micronutrient deficiencies (e.g., in iron and zinc) that are known to affect, in turn, mental and motor development in children (Golub et al., 1995; Pollitt, 1995); thus, the outcomes may vary, depending on the presence or absence and severity of deficiencies.

Iron. Infants and toddlers who are iron-deficient anemic consistently perform less well on tests of mental and motor development than their peers whose body iron stores are replete (Lozoff, 1990; Walter, 1989). Yet supplementary iron has not generally reversed the developmental delay in this age group, except in a randomized trial in West Java, Indonesia (Idjradinata & Pollitt, 1993). In other studies, the developmental reversal was restricted to those cases where the iron supplementation resulted in normalizing the child's hemoglobin level. A preventative trial with the same age group yielded equivocal findings. The motor, but not mental, development of infants fed iron-fortified formulas was accelerated, compared to controls, up to 12 months of age; but this advantage was lost at 15 months (Moffatt, Longstaffe, Besant, & Dureski, 1994).

Evidence on the effects of iron deficiency on preschoolers and older school-age children is clearer. Compared to controls, children with iron deficiency scored lower on cognitive tests and performed less well on school tests (Pollitt, Hathirat, Kotchabharkdi, Missell, & Valyasevi, 1989; Seshadri & Gopaldas, 1989). Iron supplementation led to significantly improved performance on measures of overall intelligence and on tests of specific cognitive processes among iron-deficient children

(Seshadri & Gopaldas, 1989; Soemantri, Pollitt, & Kim, 1985; Soewondo, Husaini, & Pollitt, 1989).

Research has yet to determine the role of iron in the brain in the cognitive and emotional detriments observed in iron-deficient children. It has been proposed that such effects are mediated by a deficiency in the functional activity of dopamine receptors (Yehuda & Youdim, 1989), but this hypothesis has yet to be fully tested in humans (Dallman, 1990). Alternatively, the impact of iron on cognitive performance may be mediated by changes in motivation or emotion that interfere with attentional processes which, in turn, interfere with cognitive performance. This question—how changes in iron status translate into changes in cognitive and noncognitive performance—remains an important area for future research.

Iodine. Maternal iodine deficiency in early pregnancy and associated thyroxine deficiency impair the development of the fetal central nervous system and can result in frank, irreversible cretinism in the child. Studies in Ecuador (Fierro-Benitez et al., 1989; Trowbridge, 1972) showed that correction of the maternal iodine deficiency before conception or in early pregnancy can improve the mental performance of offspring. Comparisons of primary school children in China, in areas with iodine deficiency versus areas with normal iodine intake (Ma, Wang, Wang, Chen, & Chi, 1989) and of goitrous vs. non-goitrous children in Chile (Muzzo, Levia, & Carrasco, 1987) showed better mental and psychomotor performance in the latter groups.

Two double-blind⁴ intervention studies of primary school children yielded contradictory results. An intervention with goitrous Bolivian primary school children reduced the goiter rate but had no effect on physical or mental performance (Bautista, Barker, Dunn, Sanchez, & Kaiser, 1982), whereas iodized oil given to iodine-deficient children of similar age in Malawi did have a positive effect on mental

and certain psychomotor test performance (Shrestha, 1994).

Zinc. Severe developmental zinc deficiency in laboratory rats disrupted brain growth and morphology and led to long-term behavioral changes that were qualitatively similar in many respects to those produced by general undernutrition (Golub et al., 1995). However, since severe induced zinc deficiency produces anorexia, it is difficult to discriminate between the effects of low zinc intake and an overall decrease in nutrient intake. Studies of marginal and moderate zinc deficiency in young monkeys have demonstrated effects on activity level, exploration, and performance on some cognitive tasks (Golub, Gershwin, Hurley, & Saito, 1985). In stunted school-age children, however, no differences were found between groups varying in zinc status, or within groups in response to zinc supplements, in scores on standardized tests of attention (Gibson et al., 1989).

At present, no experimental studies have discriminated among the effects of deficiencies of zinc, iron, protein, and energy. Thus, how different deficiencies may interact is unknown.

Future Directions

New understanding of the role of nutrition in child development points to suggestions for future research.

Biological and Behavioral Mechanisms

Research efforts are gradually revealing a finer-grained picture of the processes linking nutrition and observable behavior. Various mechanisms involving both biological and behavioral aspects of development are implicated and bear investigating.

Biological. Earlier research linking PEM and behavior suggested that undernutrition interfered with the development of the central nervous system. Undernutrition reduced brain weight and the number of brain cells, which in

turn were seen as the cause of irreversible detriments in cognitive and motor performance (NAS, 1973). This emphasis on brain growth focused attention almost exclusively on the period of maximal brain growth, seen as the period of greatest vulnerability.

New findings indicate, however, that periods before and after that of maximal brain growth may be equally important. It is now understood that critical aspects of central nervous system development—for example, gliogenesis, macroneurogenesis, and early glial and neuronal migrations—precede the period of maximal brain growth. Other later processes, such as synaptogenesis and myelination, may also be sensitive to insult and remediation (Levitsky & Strupp, 1995; Strupp & Levitsky, 1995).

Research during the last decade has shown that the effects of undernutrition late in gestation are similar to those occurring early. In the case of previously undernourished animals, for instance, the period of brain growth can be extended, and remarkable recovery has been observed. Such evidence is leading researchers to consider a broader range of possible biological mediators, including brain differentiation and changes in neuroreceptor sensitivity. For example, perturbations at the subcellular level, as suggested by alterations in sensitivity to pharmacological challenges, persist after periods of early undernutrition and nutritional rehabilitation (Levitsky & Strupp, 1995).

Behavioral. In the mid 1970s the concept of *functional isolation*, referring to restricted interaction with the environment, was proposed to explain the long-term behavioral effects of early undernutrition (Levitsky, 1979; Levitsky & Barnes, 1972). It was hypothesized that it is the differential experience of the organism rather than disrupted brain growth that mediates the effects of early undernutrition over time. The child who is undernourished attempts to maintain energy balance by reducing energy expenditure and withdrawing

from environment stimulation. Such withdrawal limits the child's capacity to take in environmental information and thereby acquire the skills and knowledge necessary for normal behavioral development (Levitsky & Strupp, 1984). This concept arose from evidence suggesting that the behaviors affected by early undernutrition were similar to those produced by early environmental isolation.

Although the functional isolation hypothesis was initially developed as an alternative to a purely biological explanation of nutrition-mediated behavioral deficits, the two explanations may in fact be compatible rather than conflicting. Functional isolation may actually influence both central nervous system and behavioral development. While not all aspects of the CNS may be sensitive to environmental influences, and the extent of effects may be relatively small (Bedi & Bhide, 1988), evidence from behavioral neuroscience studies illustrates how restricting experience may adversely influence development (Diamond, 1988; Greenough & Black, 1992) and efficiency (Stone, 1987) of specific brain structures and processes. In addition to the influence of functional isolation on both brain and behavior, subsequent neural changes may further accentuate the effects of functional isolation on ultimate development.

Recently, the functional isolation proposition has been elaborated to explain in greater detail some of the mechanisms that may contribute to long-term adverse effects of undernutrition on cognitive development (Pollitt et al., 1993). This revised proposal hinges on the well-documented effects of undernutrition on body size, neuromotor development, and physical activity. If the child is small and physically underdeveloped and inactive, he or she may

- (1) induce behaviors and social responses from caretakers that would generally be reserved for younger children;
- (2) undertake less exploration of the environment; and

- (3) consequently lag in acquiring the motor skills, cognitive abilities, and social behaviors that typify normal development.

These patterns can operate independently and interactively, with cumulative effects, such that the child ultimately falls behind in competencies attained by well-nourished children. Investigating how nutrition promotes individual differences in children's motor skills, exploration, and play behavior would provide a welcome test of this hypothesis.

Assessing Nutrition

Focusing on individual nutrient deficiencies is particularly problematic within populations in which undernutrition is a major public health concern. With the possible exception of populations where this is not a problem, studies of single nutrients are no longer adequate (Golub et al., 1995; Pollitt, 1995)—as indicated by the coexistence of multiple nutrient deficiencies (Schürch, 1995), complex interactions in the absorption and utilization of nutrients, and the demonstrated effects of different nutrients on CNS function. Moreover, failure to account for the relationship between PEM and micronutrient deficiencies has led to inconclusive findings regarding the causal role of distinct nutrients on cognitive outcomes (Pollitt et al., 1993).

Too often studies are marred by a lack of information on the overall nutritional status of the population in question. For example, studies testing the functional consequences of particular nutritional deficits (e.g., energy) have floundered, because the prevalence of the deficit in the populations under study was negligible (Allen, 1993). It is important, therefore, to obtain survey data on nutritional indicators before implementing field studies. Further, if limits in knowledge and technology preclude the use of laboratory measures to determine nutrient status (as in the case of zinc), then alternative procedures (e.g., response to treat-

ment) should be used to establish baseline values. While this approach could be costly, the yield to science would be rewarding.

Measuring Outcome

Just as the field is moving beyond an emphasis on single nutrients, so the focus on cognitive development to the exclusion of biological and psychosocial development no longer suffices in the investigation of undernutrition effects. Research is expanding to encompass the broader context and the multiple risks that interact with nutrition in determining outcomes for the undernourished child.

Assessments of affective characteristics, e.g., temperament, reactivity to stress, self-regulation, and emotional regulation, stand to shed light on the effects of undernutrition on the behavioral adjustment and psychological functioning of undernourished children. Although such attributes are typically treated as innate, increasing knowledge of the CNS processes that underlie individual differences in temperament and link temperament and cognitive processes makes research in this domain promising. One issue is whether the nutritional environment could modify the genotype of temperament.

Likewise, studying the effects of undernutrition on the simultaneous or sequential relationships between developmental systems is also critical. The link, for example, between neuromotor and cognitive delays in the undernourished infant merits attention in light of new information showing that self-locomotion is an antecedent to perceptual development (Bertenthal & Campos, 1990; Lockman & Thelen, 1993).

We must understand more about the neural mechanisms through which undernutrition and related factors translate into individual differences in behavior and development. Recent advances in biomedical methodology promise a more direct assessment of crit-

ical nutrition-sensitive CNS processes. For example, nuclear magnetic resonance spectroscopy allows noninvasive assessment of changes in CNS energy metabolism (Holtzman, McFarland, Jacobs, Offut, & Neuringer, 1991) and has been used with some success to distinguish the CNS metabolic concentrations of at-risk and normal infants (Cady et al., 1983).

Finally, the possible effects of undernutrition across generations must be identified. At issue is how biological and behavioral mechanisms may contribute to the transfer of a burden of undernutrition from one generation to the next (Susser & Stein, 1994). Several longitudinal studies of severe and mild-to-moderate undernutrition in early life, launched in the past, offer unique opportunities for the follow-up of new generations.

Accounting for Factors That Modify Effects

Studies are needed of the effects of undernutrition over the lifespan, from the earliest stages, including the prenatal, to old age. But, while age may be related to the outcome, we must identify what factors related to increasing age act to modify outcomes. Obviously, effects are not necessarily mediated only by changes in the CNS occurring during the specific period of maximal brain growth (Levitsky & Strupp, 1995). How, for instance, is the educational achievement and progress of children hampered by undernutrition (Soemantri et al., 1985)? Or how does formal education limit the adverse effects of early undernutrition?

Future studies should also attend to the role of intra-individual and environmental factors that protect against or accentuate the risks of undernutrition. Research designs that would, for example, track the chain of relationships—of effects of undernutrition on the child's behavior, the child's behavior on caregiver behavior and vice versa, and possible buffering or deleterious factors on these relationships—would go a long way toward clari-

fying how undernutrition affects behavioral outcomes and development.

Finally, what is needed are studies that capture the broader context, the “human condition.” Undernutrition among children in economically impoverished populations is likely compounded by multiple risk factors—by conditions besides undernutrition. With few exceptions (Chavez & Martinez, 1984), the recognition that such interactions do exist has failed to lead to studies that attempt to disentangle them or that seek to identify the factors that either increase or decrease the risks. It is, for example, important to understand why, in one study, poor, undernourished children experienced significant developmental delays, while middle-class children who suffered from severe undernutrition secondary to medical problems showed no such effects (Pollitt, 1987).

Conclusion

In summary, there is convincing evidence that general undernutrition and iodine and iron deficiency can impair behavioral and cognitive development. Iodine deficiency has its maximal effect in utero, while that of iron deficiency and general undernutrition is greatest in the early postnatal period. These effects, however, are no longer believed to be limited to the phase of maximal brain growth or to be mediated exclusively through neuroanatomical structural changes. Studies intended to show or reverse the effects of PEM do not allow a clear causal attribution to protein or energy as determining factors, and confounding with iron remains a possibility. Other single nutrients could have effects on behavioral development, but this has not yet been convincingly demonstrated in humans. The incidence and magnitude of nutritional effects on behavior can be greatly exacerbated by other risk factors and insults; they can also be reduced or eliminated by buffering factors.

Such effect modifiers should be considered in all research and policy discussions.

While we encourage further research on the effects of undernutrition on human development, there is, finally, a great need to study the societal impact of undernutrition in populations in which most members are affected. Of great concern are populations which have been exposed to natural and man-made famine conditions. Such research would involve calculating the social and economic cost of limiting the potential of human capital within a society and estimating the benefits that would accrue through the prevention of malnutrition.

Notes

¹Anthropometric (human body) measurements are generally used around the world to classify children as well-nourished or nutritionally at risk (i.e., stunted or wasted). The World Health Organization (WHO) has a set of reference standards for weight and height used to compare trends among different countries and to estimate the prevalence of undernutrition. The 50th percentile, that is, the median of the normal distribution of a particular anthropometric measurement (e.g., weight) at a given age, is generally used as the criterion for comparisons. The WHO references are based on the respective anthropometric measurements obtained by the United States National Center for Health Statistics (NCHS). Although weight-for-age is a criterion often used to classify children at-risk, it is recognized that this measure is not a fully satisfactory criterion because the weights of some children, which may be low for their chronological age according to the WHO reference, may be in line with their short stature.

²Dietary quality refers to a diverse diet that includes protein and micronutrients (e.g., iron) of animal origin.

³In this context, bioavailability indicates that absorption of nutrients varies depending

on their source. For the human infant, for example, the iron contained in human milk has a higher bioavailability than that in cow's milk. This difference explains in part why the prevalence of iron-deficiency anemia is much lower among infants who are breast fed, compared to those fed cow's milk.

⁴In a double-blind experiment, neither the subject nor the person who implements the treatment nor the person who analyzes the data knows which subjects make up the experimental group and which the comparison group.

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IDECG was established in 1986 to study dietary energy intake in relation to the health and welfare of individuals and societies. The IDECG is sponsored by the United Nations University, with the endorsement of the Administrative Committee on Coordination of the United Nations/Subcommittee on Nutrition and the International Union of Nutritional Sciences. One of the objectives of the IDECG is the compilation and interpretation of relevant research data on functional and other consequences of deficiency, change, or excess of dietary energy intake.

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COMMENTARY

Nutrition: Essential Ingredient for Child Development

Johanna T. Dwyer

New Views on Nutrition's Role in Child Development

The report of the Task Force on Nutrition and Behavioral Development in this issue provides a welcome update of evidence on the importance of nutrition as one essential ingredient in child behavioral development.

The children of the poor in developing countries are most at risk of undernutrition. Protein calorie malnutrition still exacts a heavy toll. It contributes to over half of all deaths of young children in developing countries, largely by worsening the vulnerability to or effects of certain infectious diseases (Pelletier, 1994). Protein calorie malnutrition was originally thought of as a protein deficiency. It is now known to be due primarily to shortages of food energy, often accompanied by disease and micronutrient deficiencies. Its effects involve both physical and behavioral development over the short and long term.

Nearly 1,000 million persons, many of whom are children and nearly all in developing countries, suffer from dietary deficiencies of iodine, vitamin A, or iron, and another 1,000 million are at risk of these deficiencies (World Bank, 1996). In contrast, these deficiencies, with the possible exception of iron, are more rare in highly industrialized countries such as the U.S. Child undernutrition today usually involves multiple nutrient deficiencies, and other environmental stresses. Child nutritional status is the outcome of the interplay of biological, social, and economic factors at both the national and family level (UNICEF, 1991). Infectious diseases, lead and other environmental toxicants, child neglect, poor school-

ing, and poverty all interact and increase its ultimate ill effects. These environmental and social contextual factors must be recognized and dealt with to craft effective interventions.

The effects of undernutrition are also multiple. These can involve not only illness but cognitive deficits, neuromuscular delay, and alterations in affective processes.

Undernutrition and dietary deficiencies also occur in affluent countries. A few examples suffice. Half of neural tube defects may be due to poor folic acid nutritional status of mothers during the organogenesis of the fetus (Committee on Genetics, 1993; Zimmerman & Shane, 1993). Many poor pregnant women and children living in deteriorated housing still have blood lead levels that increase risks to children of compromised behavioral development (Agency for Toxic Substances and Disease Registry, 1988; Brody et al., 1994; Pirkle et al., 1994). New evidence suggests that poor nutrition and health in a pregnant woman may put the fetus at increased risk for certain chronic degenerative diseases, including coronary artery disease and hypertension (Barker, 1992,1994).

Implications for Crafting Effective Nutrition Interventions

The Task Force's findings and other recent developments provide the scientific basis for devising effective ways and means to alleviate the adverse effects of undernutrition on child development.

Integrated programs. Dr. Abraham Horwitz, director emeritus of the Pan-American

Health Organization/World Health Organization, argues that the three essential conditions for good nutrition are food, health, and care. With respect to food and health, new technologies are now available that help to prevent and control many prevalent infectious diseases and deficiencies of iodine, iron, and vitamin A that affect children under 5 years of age (WHO/UNICEF, in press). Care includes prenatal care, continuing with prolonged breast-feeding, proper supplementary feeding, and the fostering of the growth and development of children through timely access to health services and a healthy environment. Prevention and treatment of child undernutrition require not only food and health measures but also emotional support, stimulation, and education and help for caregivers (Brown & Sherman, 1995). Therefore, programs designed to alleviate undernutrition must be broad based, well integrated, and well administered. They require nutrition, health, behavioral science, and organization and management expertise (Horwitz, 1996).

Interdisciplinary involvement. Dr. Nevin Scrimshaw, winner of the World Food Prize, believes that most ill health and premature death in children are preventable if poor diet and other adverse environmental and lifestyle factors can be minimized. To make this new preventively based paradigm a reality Scrimshaw calls for a “multidisciplinary effort in which the role of the social scientist is as important as that of the health scientist in promoting health; both have more to offer in the effort than those exclusively concerned with curative medicine” (Scrimshaw, 1996, p. 67). The promotion of breast-feeding and improvement of household food security to provide adequate child access to food are only two of many areas that benefit from the inputs of social scientists.

Broader measures of success. Nutritional objectives need to be more fully incorporated into the policies and programs that affect children’s development. Needed are broader measures of success that include the potentiating

effects of nutrition interventions on development and health improvement. And findings must be communicated more effectively to policymakers. Social and behavioral scientists can help by conducting hypothesis-driven research employing better, broader, and more valid measures of the factors that may give rise to effects on development. More extensive measures of health outcomes should also be employed. Alleviating vitamin A deficiency in developing countries, for example, has multiple effects—including decreases in nutritional blindness, fewer complications from infectious diseases such as measles and acute diarrhea, and a nearly 25% decrease in mortality among children under 5 years of age (Beaton, 1993).

Political will. Technology alone is not enough; political will and administrative skill are also needed. For example, protein calorie malnutrition has political and socioeconomic causes that are not simply due to food shortage. Its prevention involves devoting more care and resources to socioeconomically deprived and nutritionally vulnerable groups in the population and thus is politically complex. Similarly, the control of iodine deficiency disease depends as much on political will and the availability of an infrastructure that can sustain iodination efforts as it does on technical expertise, and the same can also be said for most dietary deficiency diseases (Hetzel & Pandav, 1996; Mamar & Dunn, 1995).

Conclusion

The challenges that remain are to design politically acceptable, cost-effective intervention programs that reach children at risk with food, health, and care. They must be well funded, sustainable, and flexible enough to continue even as economic and social circumstances change. Experts in child development are essential to this effort. The payoffs include not only better physical health for children but more global enhancements to child and national development.

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COMMENTARY

Nutrition, Cognitive Development, and Economic Progress

Judith McGuire and Donald Bundy

In the mid-to-late 1970s, there was a flurry of research on the interrelationship between nutrition and cognitive development. These early results, much of which are cited in the Task Force report, strengthened the argument that malnutrition was, in turn, a critical limiter of economic development in developing countries. This conclusion generated greater political commitment and action to address malnutrition. In the 1980s developing countries initiated an unprecedented number of large nutrition programs, with support from bilateral and multilateral donors. The Task Force review strengthens yet again the case for the importance of nutrition; it is hoped that continuing increases in national programs will result.

The community of developmental research has yet to fully document, however, the effects of nutrition programs (and there were many) on cognitive development, school performance, or, ultimately, labor productivity. Although economists, through analyses of national data, have repeatedly shown that child nutrition affects both the fostering and utilizing of education (Glewwe, Jacoby, & King, 1996), and that child nutrition and schooling jointly determine adult income (Thomas & Strauss, 1992), the explicit link between nutrition programs in childhood and later income is yet to be specified.

Since 1990, a new wave of political interest in the nutrition–cognitive development link has focused largely on the effects of micronutrients (especially iodine and iron). The calculation of millions of IQ points lost to iodine deficiency, while of perhaps dubious academic validity, has moved several countries to iodize their salt. This calculation was facilitated by a meta-analysis of 17 studies on the effect of iodine deficiency on

IQ (Bleichrodt & Born, 1994). Recent work on iron is also helping developmentalists and practitioners make convincing arguments about the need to address anemia, the most prevalent and neglected nutrition problem in the world (Partnership for Child Development, 1997).

Evidence from research, however, is not enough to make public policy. The Task Force report not only summarizes the justification for addressing malnutrition but also gives the reader a better idea about *how* to intervene and *when* and *with whom*.

Early Child Development Program (ECD). On the “how” question, the report presents a number of options. First is the Early Child Development program which includes food, psychosocial stimulation, attention to preventing health problems, and child care. Several successful experiences with ECD show that such programs can be effective and have long-term impacts. But although the general ingredients of successful interventions are known, many countries may not be able to afford such comprehensive programs, particularly for the poor, without significant contributions of volunteer labor.

Supplementary feeding. A second option is supplementary feeding, which is not universally appropriate. The Task Force report clarifies that supplementary nutrition without complementary psychosocial stimulation may not result in significant improvement in cognitive or educational outcomes. Moreover, and not mentioned in the report, supplementary feeding without accompanying nutrition education and health referral does not even alleviate more immediate malnutrition effects; it is often very costly, difficult to target, and conducive to dependency

(World Bank, 1991). One of the few documented benefits is that some nutrition programs have, without any other intervention, caused parents to focus more attention on the child and provide greater stimulation (Chavez & Martinez, 1981).

Whereas most types of supplementary feeding are unhelpful, nutrition interventions in schools show great potential, yet have been widely abused. Unfortunately, too often this approach becomes part of a political game, a public relations gimmick which is mistargeted, expensive (offering high-status, nutritionally unnecessary, often imported commodities, like milk), and poorly designed (e.g., giving children a lunch just before they go home instead of a mid-morning snack or breakfast which might benefit in-school learning [Del Rosso & Marek, 1996]).

Specific therapies. A third option is to use specific therapies for specific conditions. New data suggest that anthelmintics can help correct growth retardation and excessive iron losses due to intestinal parasites. Deworming school children is highly cost-effective and reduces community-wide transmission (Awasthi & Peto, 1996).

Micronutrient supplementation is another successful intervention delivered in schools, health centers, and through the private sector. Vitamin A capsules have eliminated vitamin A blindness from Indonesia, for instance. Iron-folate supplements offer much promise for infants, school children, and pregnant women, even in the absence of other nutritional or health interventions.

Modifying behavior. A final “how-to” option is to modify childrearing behaviors and nutritional practices. The Task Force report focuses on behavior rather than on brain science, which leads to some important conclusions. First, a child’s behavior problems are much more visible and understandable to the mother, the health professional, and the policymaker than, for example, disrupted neuronal myelination.

Second, child behavior is a product not just of inborn personality but also of caregiving behaviors and physical inputs (food). Thus the problem is not medical, to be treated by a doctor, but rather social and economic, requiring multifaceted attention. Third, although behavior is the problem, it is also the solution. Mothers’ behaviors—breast-feeding and other feeding practices, affective behavior, and general caretaking—are as critical to resolving the problem as food per se. Changing the caregiver’s practices (e.g., by tying suggestions for change to the child’s growth) is a highly cost-effective way to improve nutrition; it also has the benefit of engaging the mother, and other caretakers, in more intensive care of the child.

Targeting intervention. With respect to the “when” and “with whom,” two schools of thought are reflected in the report: “the sooner the better” and “it’s never too late.” Probably both statements are true. Clearly children and pregnant women are the highest priority targets for general nutrition programs. Where malnutrition causes irreversible damage—e.g., cretinism due to iodine deficiency, blindness due to vitamin A deficiency, or intrauterine growth retardation—the timing of the intervention is critical to prevent this damage. With some other kinds of malnutrition the human body is quite resilient, but effects of malnutrition are cumulative. In these cases, although intervening early is desirable, it is still justified after the most vulnerable period to compensate for earlier deprivation and to facilitate catch-up growth.

Vulnerability to adverse and costly consequences of malnutrition continues throughout life. Thus, policymakers must be astute in identifying the target group and when to intervene. In the case of iron deficiency or short-term hunger, for example, the well-documented effects on learning and their coincidence with an age when children are in school argues for intervention at school-age. Other instances of malnutrition may call for different solutions.

Summary

The Task Force's report makes a compelling argument that to neglect the problem of malnutrition invites serious consequences to individual development and a heavy toll on the development of human and social capital. It is useful to have this message repeated. Even though researchers may not have the definitive answers—as to how, when, and with whom to intervene—governments, donors, and community activists are already taking action.

Donor agencies, like the World Bank, are initiating and supporting integrated early childhood development programs, school-based nutrition and health programs, and nutrition education programs. To quantify the consequences of failing to address malnutrition is the next research challenge; it is vital that the dialogue between researchers and policymakers continues so that research informs policy decisions and program needs inform research.

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BRIEF

U.S. Nutrition Programs under Welfare Reform

Editor

As Johanna Dwyer points out in her commentary (p. 23), the multiple nutrient deficiencies typical of undernutrition tend to be rarer in industrialized countries like the U.S. We enjoy both greater affluence overall and protections against severe deprivations. In FY 1996, for example, the Food Stamp program served 25.5 million participants, including 13 million children, at a cost of \$24.4 billion. The National School Lunch Program provided free and reduced-rate meals to 14 million low-income school children at a cost of \$3.8 billion. The Summer Food Service Program served 2.1 million children at a cost of \$246 million. And WIC (the Special Supplemental Food Program for Women, Infants, and Children), with a budget of \$3.7 billion, supported supplements and nutrition education for 7.2 million pregnant and postpartum women and their infants and children.

Nutrition programs are being cut back, however, under the new welfare reform law, P.L. 104-193, the Personal Responsibility and Work Opportunity Reconciliation Act of 1996. Although states, under the new law, are assuming authority over many entitlement programs, the federal government remains custodian of both the Food Stamp and child nutrition programs.

A variety of program changes are slated to save c. \$30 billion over the period FY 96-2002, according to the Congressional Budget Office; \$27 billion is to come from Food Stamps, \$3 billion from child nutrition programs—to include the School Lunch, School Breakfast, and Summer Food Service programs.

Food Stamps. Various measures aimed at curtailing Food Stamp eligibility are aimed at reducing the number of benefit recipients, thus leading to savings. Hardest hit will be childless

adults and current and future legal aliens who will no longer be eligible to receive Food Stamps or other benefits, beginning in spring 1997. Other changes affecting children will limit eligibility further. As part of child support enforcement, for example, noncustodial parents who fail to maintain payments will lose eligibility. Parents who have particularly high shelter costs will no longer be able to deduct these from the accounting of their income.

Child nutrition programs. The most significant changes to child nutrition programs include (1) a two-tiered reimbursement approach to child and adult day care food programs to better target low-income recipients, (2) cutbacks in reimbursements to the Summer Food Service, and (3) elimination of any School Breakfast expansion. The noncitizen provisions of the law give states the option to deny WIC and some child nutrition (not School Lunch or Breakfast) and commodity benefits to illegal aliens.

Clinton budget. The picture is further complicated by President Clinton's stated intent to revisit welfare reform legislation in the present congressional session. The Clinton administration's budget, issued early in February, increases the number of months unemployed adults can receive Food Stamps from 3 out of 36 to 6 out of 12 months and provides an important protection, that a recipient cannot be denied the benefit unless he or she refuses to take a job. The proposal also eases the shelter cap by raising the allowed deduction and removing the cap altogether in 2002. Although such adjustments would improve the prospects for families and children, upcoming negotiations seeking a balanced budget promise to pressure for further cuts, not increased spending.

Monitoring. What all this will mean for the nutrition status of the nation's children and families remains to be seen. Nonprofits and nongovernmental entities will continue to evaluate effects, and some government-sponsored monitoring is in place. The U.S. Department of Agriculture, through its Continuing Survey of Food Intakes by Individuals, tracks household food-buying and consumption patterns. And the Bureau of the Census, in collaboration with the Food and Consumer Service, added, in April 1995, questions to its Current Population Survey aimed at assessing

the prevalence and severity of food insecurity in the U.S. (Center for Nutrition Policy and Promotion, 1996). The results of this effort, expected to become available in 1997, are the first in a planned annual series that will support the monitoring of changes over time.

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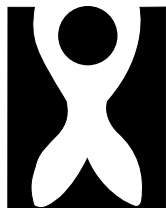
NEXT ISSUE: *Schooling, the hidden curriculum and children's conceptions of poverty.* Judith Chafel

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