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## MALNUTRITION AND DEFICIENCY-INDUCED MENTAL RETARDATION

### Introduction

This document summarizes the principal ideas presented in a report on the impact of malnutrition and environmental factors on mental development. The report will be one of the main items of discussion by an Advisory Group Meeting to be held on 5-7 May 1980 in Washington, D.C., under PAHO auspices.

This summary document, together with the report to be developed by the Advisory Group, will form the basis for the presentation by the Director to the 84th Meeting of the Executive Committee, in compliance with Resolution XVII approved at the XXVI Meeting of the Directing Council held in Washington in September/October 1979.

The complete document, which reviews recent literature with special emphasis on the experience gained in the countries of the Region, is available in the Secretariat for those Representatives who may wish to review it.

EFFECTS OF ADVERSE ENVIRONMENTAL AND NUTRITIONAL  
INFLUENCES ON MENTAL DEVELOPMENT

A Summary of Current Knowledge with Implications for Programs  
and Policies Aimed at Prevention and Remediation

The purpose of this working paper is to summarize present knowledge concerning the unfavorable consequences of adverse environmental and nutritional influences on children's mental development, in the context of program and policy implications.

Fetal Development

There are a number of adverse factors affecting fetal development, manifested by prematurity (gestation under 37 weeks) and/or low birth weight (birth weight under 2,500 g), which subsequently affect mental development. These factors relate to the poor nutritional and growth histories of the mother, her poor nutrition and weight gain during pregnancy, her inadequate health care, and her closely spaced pregnancies.(2,32)

Moreover, these conditions of low birth weight and/or prematurity are often indicative of subsequent risk of suboptimal intellectual development, and even of severe neurological handicap or mental retardation, particularly if the degree of prematurity or birth weight deficit is marked, and if serious perinatal complications are also present.(2,5,12)

There is an increased prevalence of prematurity and low birth weight in young mothers (under 19 years of age) and older mothers (older than 35 years), who also experience these adverse factors. The prevalence of low birth weight infants is as high as 40 per cent in some developing countries. Because of the association between impaired mental development and low birth weight, an appreciable reduction in the frequency of low birth weight infants in a population at risk is likely to have a significant effect in reducing the risks of impaired mental development associated with this problem. There is considerable evidence indicating that appreciable reductions in both infant mortality and in the frequency of low birth weight can be brought about with improved conditions of sanitation and health care.(22)

Nutritional Supplementation During Pregnancy

What can be said about the specific effects of nutritional supplementation during pregnancy on birth weight? Some reduction in the

frequency of low birth weight can be brought about through systematic nutritional supplementation of pregnant women. Supplementation during pregnancy is most likely to be helpful if it can be focussed primarily on subgroups at greatest risk of having low birth weight or premature infants.(21,23)

Several behavioral characteristics observable in the neonatal period seem to be somewhat favorably influenced by supplementation, which is associated with better visual attention and habituation, less fussiness during testing, and fewer negative responses to negative stimulation. Supplemented infants are also judged to be less apathetic during observations of caregiver-infant interaction at 4 and 8 months.

Favorable effects on perinatal mortality, low birth weight and physical growth and development can be achieved through improvement of health care and supplementation of the diets of pregnant women and infants. The effectiveness of such efforts could probably be increased by a fuller understanding of the relative contributions of calories and protein, by intervention strategies which can bring about more substantial increases in total diet and which more sensitively reach groups which are most at risk.

#### Postnatal Influences

Adverse socioeconomic conditions associated with poverty have a limiting effect on mental and physical development. There are important variations within poor populations which affect their children's development, such as varying degrees of socioeconomic and environmental adversity, and patterns of child care and mother-child interaction.

It has been well-recognized for many years that malnutrition as a public health problem is generally most prevalent in poor populations living under adverse socioeconomic and environmental conditions, including poor housing and sanitation, exposure to infectious and parasitic diseases, inadequate health care, limited food availability, restricted educational and occupational opportunities, large family size, and unfavorable feeding and child care practices.(7,33). All of these conditions are capable of playing a significant role in limiting a child's growth and development, both physical and psychological.

In many countries of the world, children from poor families in the lower socioeconomic levels tend to perform less well than children from middle class homes in tests of intellectual development; they also tend to do less well in school, and to have substantially more limited school experience.(11,17,34) A number of Latin American studies have documented such test differences very clearly, not only in preschool-age children,(27) but also as early as two years of age. These differences

are not primarily a reflection of lower levels of basic competence or intellectual potential in the low-income children; rather, they reflect the fact that many very poor children grow up under adverse socio-environmental conditions that are not fully supportive of their developmental potential.

Within very poor populations at risk of early malnutrition it is possible to identify variations in particular features of the child's home and family environment which may either increase or reduce the likelihood of severe malnutrition occurring in particular families,(10,31) i.e., the mother's competence and the nurture and support for the child's social, emotional and cognitive development.

Unfavorable early child care practices and dysfunctional patterns of caregiver-infant interaction may contribute to an increased risk of malnutrition, growth retardation, and suboptimal behavioral development.

The infant or young child's altered nutritional status, as reflected in physical appearance, general demeanor and behavior, may affect the manner in which the mother or other primary caregiver responds to and cares for the child, thus potentially altering the child's early experience and subsequent development in significant ways.(6,14)

#### Mild to Moderate Malnutrition

It has been extremely difficult to make meaningful evaluations of the independent effect of mild-to-moderate malnutrition as such on mental development in children, independently of the concurrent influence of various adverse social and environmental conditions typically associated with endemic malnutrition, and capable in their own right of affecting children's intellectual development.(1,25)

Many studies of mild-to-moderate malnutrition in poor populations have attempted to evaluate the relative influence of socio-environmental factors and the nutritional variations reflected in physical growth, through partial correlation or regression analyses.

The results tend to indicate that both socio-environmental factors and nutritional history (physical growth) may make some independent contribution to variation in intellectual competence, but estimates of the percentage of variance attributable to each of these two major sources of influence vary considerably from study to study.

#### Severe Malnutrition

There have been a good many studies of the behavioral consequences of severe protein-calorie malnutrition occurring in the first several years of life, and serious enough to warrant hospitalization for treatment

and remediation. When examined during and shortly after rehabilitation, such children typically show substantially retarded physical growth and motor development, and they perform appreciably below norms.(4,9,15)

These children tend to perform less well than controls on a number of intelligence and perceptual/cognitive tests, and tend to do less well in school.(8,18,19) Here too, however, as in the case of mild-to-moderate malnutrition, one needs to be cautious in interpreting these findings as evidence of a direct causal link between early clinical malnutrition and subsequent subnormal mental functioning.

Severe protein-calorie malnutrition occurring in the first few years of life may well be implicated as one of the various environmental factors leading to subsequent impaired mental development. The effects appear to be more marked the more severe the nutritional deprivation, and the longer it continues without treatment. If nutritional treatment and rehabilitation occur early in the first year, the chances of recovery of normal or near normal intellectual functioning appear quite good.

#### Intervention Programs

One of the major forms of intervention employed in dealing with malnutrition is the hospitalization and treatment of clinically ill infants and preschool children with severe malnutrition of the marasmus of kwashiorkor type.

The earlier the treatment and rehabilitation of these children, the less the risk of severe developmental impairment.(29) In recent years, some treatment programs have incorporated procedures of care intended to ensure that the infant or toddler is not deprived of adequate social and physical stimulation during treatment and rehabilitation, or to provide added experience and stimulation during this period.(24,26) In general, these procedures seem to offer some facilitation of the recovery process during treatment and rehabilitation, although their long-term benefits are likely to be very much influenced by the nature of the enduring environments to which the children return after hospitalization.

Several major nutritional supplementation studies have been undertaken to determine whether the mental development of children at risk of mild-to-moderate malnutrition can be enhanced through improvement of their health and nutritional status. The findings thus far indicate some degree of association between total supplemented calories ingested and mental development, but these relationships are generally quite small and not consistent at different ages, across different tests, and for boys and girls. Nevertheless, there are a number of provocative trends in the findings. The effects of supplementation vary from different subgroups in the population (as was the case with birth weight); a slight but

significant relationship has been found within the socioeconomically poorer, but not in the relatively better off families. There is also some indication that supplementation may have a somewhat greater effect in the poorest families.(20)

Once a child has suffered from early malnutrition, even of the severe type, the risk of subsequent impairment of mental development will depend very much on the quality of the child's home and family environment. Economic factors, physical growth and nutrition each affect cognitive development by about the same degree.

### Mechanisms

What are the mechanisms through which malnutrition might exert its impact on behavioral competence and mental development in children? Are there specific perceptual-cognitive, learning, or motivational processes which might be particularly vulnerable to the impact of nutritional deficits?

It was assumed that the brain changes produced by malnutrition led directly to an impairment of learning ability, and thus to subnormal intellectual development or mental retardation, which was considered typically irreversible. This is not so. Malnutrition exerts its major influence on behavioral competencies through dysfunctional changes in attention, responsiveness, motivation and emotionality, rather than through a more direct impairment of learning potential. Thus, the malnourished child's interaction with his/her environment is altered in ways that make him/her less likely to seek out, utilize, and respond to available opportunities for learning and social interaction.

Tasks which require the capacity to mobilize and sustain attention are particularly affected by malnutrition, e.g., simple tasks of short-term memory, or tasks in which incidental learning is possible.

The impact of malnutrition on children's attentional and motivational competencies is emphasized also by recent reports of altered work styles, or responses to cognitive demands shown by Mexican preschool children having experienced early clinical malnutrition,(10) as well as less favorable performance on tasks requiring sustained attention by children in Boston (USA) with iron deficiency.(28)

Since malnutrition affects mental development primarily by altering the child's attentional competencies, motivation, and responsiveness to learning opportunities in the environment rather than by permanent impairment of learning capacity, prospects for remediation and reversibility

should be much more hopeful. For example, it should be possible to enhance the malnourished child's environment and his/her interaction with it in the hope of improving his/her attentional and motivational skills.

The child's health and nutritional status, as well as his/her opportunities for learning and social development are essential and integral components of developmentally supportive child care and child rearing environments.

A composite measure of the quality of the home environment explains considerably more of the variation in cognitive test performance than supplementation does, particularly from five years on (three to five times as much). Health care and other services should focus on "high risk" families to support their capacity to promote child care and child rearing environments in the home. Enhancement of these children's subsequent learning opportunities through increased availability of formal and informal educational experiences in neighborhoods, day care center, or school also help to minimize the potential long-term effects of severe early malnutrition. Families who seem to be coping more successfully with the general socioeconomic and environmental constraints confronting them may well provide valuable leads for helping those who are coping less well. In fact, such families may well be able to play a significant role in supporting others at greater risk through involvement in informal neighborhood networks.

#### Iodine and Iron Deficiencies

While there is no question about the substantial impairment of mental development in children with severe endemic cretinism, it is not yet clear whether there is a spectrum or continuum of subnormal intellectual functioning associated with milder forms of endemic goiter. Several studies suggest this possibility on the basis of somewhat lower visuomotor or cognitive test performance in children living in areas of endemic goiter but without obvious signs of endemic cretinism,(16,30) and on the basis of significantly higher test performance in children whose mothers were given iodized oil prior to the fourth month of pregnancy.(13) Even if the evidence for a continuum of mild-to-moderate impairment of intellectual development associated with milder forms of endemic goiter or iodine deficiency is still unclear, it is obvious that the need for widespread prophylactic measures to eliminate iodine deficiency and its adverse developmental consequences is very great indeed.

There is little or no evidence to indicate that iron deficiency as such, in the absence of more pervasive malnutrition, leads to significant impairment of mental development. There is important recent evidence suggesting that if one uses sufficiently sensitive measures, mild forms of iron deficiency, even in the absence of anemia and undernutrition, may adversely affect performance on cognitive tasks requiring the mobilization and sustaining of selective attention.(28)

### Policy and Program Implications

What are some of the major implications and conclusions which can be derived from our experience with intervention programs thus far? The goal of fostering mental development in children living in poverty is most likely to be achieved through comprehensive programs meeting the various basic needs of poor children and families. The most effective intervention programs are likely to be those which are concerned with a child's nutritional and health needs, supporting and enhancing the family's capacity to provide developmentally facilitative child care and child rearing environments, and with the provision of increased opportunities for formal and informal educational experiences in day care centers or schools.

Intervention is most likely to be effective, as well as more feasible economically, if it can be focussed and structured so as to reach, in particular, those children and families considered to be at greatest biological or socio-environmental risk of impaired development.(35)

Better techniques need to be developed for identifying children and families at greatest risk of malnutrition and impaired mental development within poor populations, and more effective strategies for reaching highest risk families, who are frequently the least accessible to intervention.(3,35) Better understanding of the characteristics and coping strengths of poor families who have proved to be less vulnerable to the socioeconomic and environmental circumstances confronting them is also needed. Development of less formal, community based support systems which may involve neighborhood educational programs, mutual assistance or self-help family groups, and encouragement of greater utilization of available supportive services, is also an important area of work.

A major goal of all programs should be to support and strengthen the family's capacity to provide a home environment adequately supportive of the normal growth and mental development of its children over the long run.

Opportunities for learning and intellectual growth should be enhanced by strengthening preschool and elementary school programs, and increasing their availability.

The optimal developmental period for intervention will depend on the nature and severity of the risk involved, as well as corresponding costs and benefits. Certainly ensuring adequate nutrition and health care during pregnancy is important if one is concerned with minimizing problems of fetal development and perinatal complications which represent a threat to the child's later development. Similarly, if the infant's

early postnatal development is threatened by severe family socio-environmental stresses, one would want to intervene as early as possible in such high-risk situations,

In home situations where the environment is reasonably supportive, intervening with added environmental stimulation as early as the first year of life is not necessarily essential to promote the development of cognitive competencies. Enrollment in enriched preschool programs by three years of age produces clear gains in such children, and there is no systematic evidence indicating these benefits would have been significantly greater if the children entered such a program earlier. Conversely, there may be other sound reasons for enrolling one- and two-year olds in day care centers, such as to effectively reach them and their parents in order to improve health care, nutrition and general child care.

Particularly during infancy and the preschool years, in many settings necessary comprehensive services can probably best be provided and coordinated through the health care system; at school age, they might be provided and coordinated through the educational systems.

Strategies of intervention should be appropriately adapted to meet the particular needs, cultural characteristics and ecological settings of the communities served. Where feasible, intervention programs should build on informal or formal systems already functioning in neighborhoods or communities. Community members should be encouraged to become involved in the planning and development of intervention programs appropriate for their neighborhoods, whether of the formal or informal type.

One of the major requirements for developing sound intervention programs is to build in systematic procedures for evaluating the effectiveness of the particular intervention strategy under consideration, in the field setting.

Despite the generally modest results achieved by these major intervention efforts thus far, it seems essential that we continue to direct major research and development efforts at the design of more effective strategies of intervention for optimizing the growth and development of children who live in adverse environments and are at risk of both malnutrition and suboptimal intellectual development, or have already experienced severe malnutrition.

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