MALNUTRITION AND MENTAL CAPACITY[1]

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The relationship between mental development and chronic undernutrition in the preschool and primary school years is not clear. Recent studies suggest that although good nutrition may play an important role, it must be combined with an appropriately stimulating environment if proper intellectual development is to be achieved.

Numerous data in the literature, based on animal experimentation and observations in humans, confirm that severe undernutrition in early life delays brain development (*1-9*). The occurrence of many biochemical alterations and clear retardation of mental development has been described during this period. Follow-up studies of animals or children who have suffered from severe early malnutrition have demonstrated that brain metabolism and mental performance are affected, and that in all probability this damage is definite (*3, 5, 9*).

In recent years there has been marked interest in whether chronic undernutrition during the preschool or school years modifies behavior and mental capacity. This problem is of extraordinary importance because almost 70 per cent of the world's population now suffers from chronic undernutrition in varying degrees (*10*). If it does significantly modify behavior and mental capacity, undernutrition could constitute one of the major obstacles to the progress of underdeveloped countries, since for their advancement they need highly qualified individuals at all levels.

Different investigators have noted that preschool children from poor families grow less and have a slower maturation rate than other children (*3, 5*). A higher frequency of retarded mental and motor development has also been observed at the same time. From current experimental data, it may safely be assumed

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Psychological tests such as these play an important role in research on the relationship between nutrition and mental development of children.

that retarded growth and maturation is the consequence of undernutrition.

We cannot be so certain as regards mental and motor impairment. There are many environmental factors that may negatively influence intellectual capacity. Unfortunately, the social groups that suffer from malnutrition are precisely those that are outside the mainstream of society because they have very low educational, cultural, and sanitary levels. All these factors contribute to inadequate stimulation for mental development.

When studying groups of low socioeconomic status and intellectual performance, as in slum areas, a significant relationship between growth retardation and low intellectual capacity may be observed (Figure 1). A similar correlation may be seen between animal protein intake and intelligence quotient (Figure 2), so that those children consuming a smaller proportion of

FIGURE 1–Height and mental development quotients in preschool children from 1 to 5 years of age.

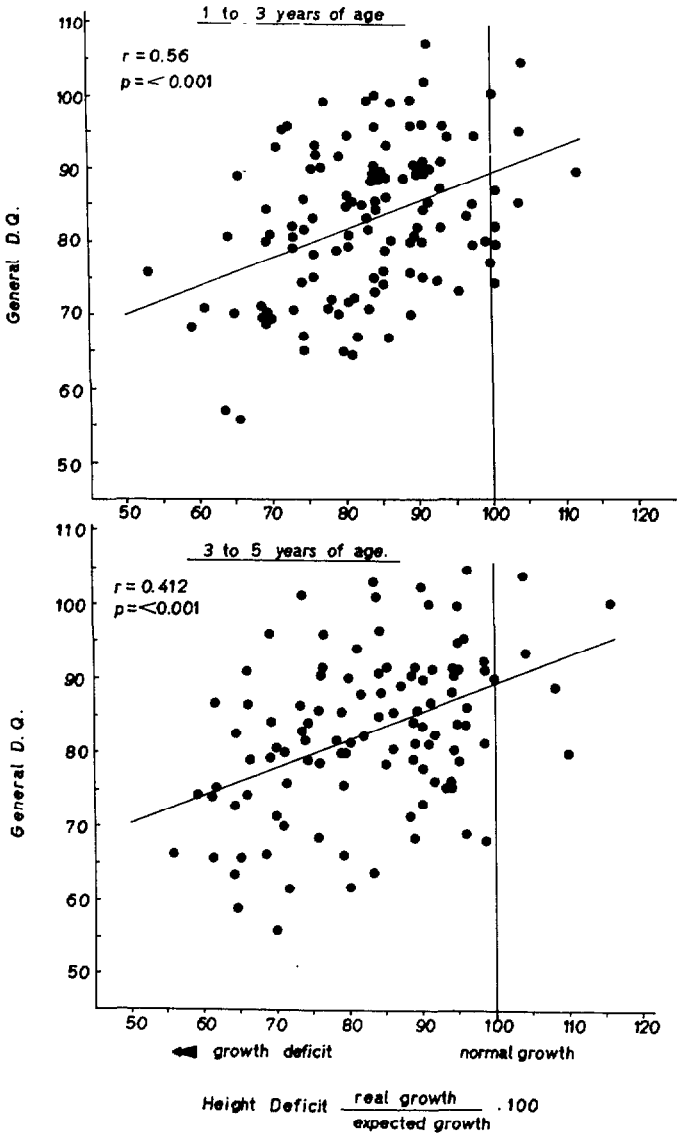
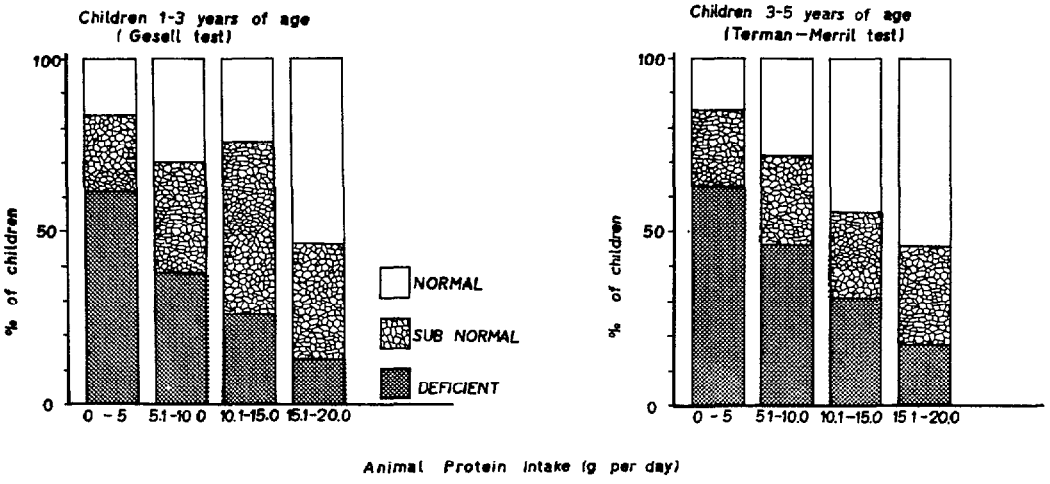


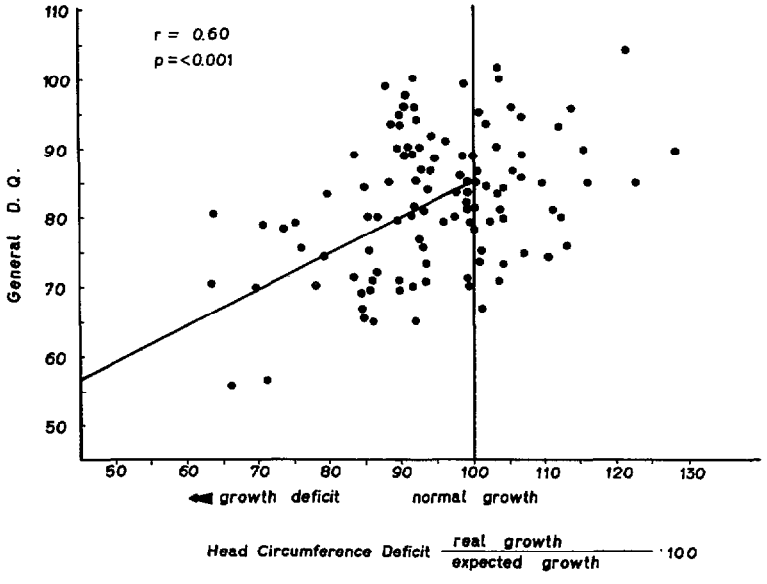
FIGURE 2–Percentage of mental normality, subnormality, and deficiency in preschool children with different rates of animal protein intake.



animal proteins have significantly lower intelligence quotients. This correlation is not observed when analyzing the total amount of caloric intake. In children under three years of age a significant correlation can also be observed between cranial growth retardation and intelligence quotient (Figure 3). This correlation ceases to be significant when cranial growth is within normal limits (*7*).

All these correlations, even though very suggestive, do not allow us to conclude that malnutrition *per se* is the cause of mental impairment. Even in slum areas with more or less homogeneous populations, children found

FIGURE 3–Head circumference and mental development quotients of preschool children 1 to 3 years old.



to be nutritionally normal presumably come from better-educated and better-off families. It is therefore possible that malnutrition could be a concomitant factor and not the cause of the impaired development quotient. On the other hand, even children with acceptable nutritive status from slum areas tend to have lower IQs than preschool children belonging to groups from a higher socioeconomic level. Thus nutritional factors cannot be the only cause conditioning the high incidence of mental capacity deficit among the poor.

The high frequency of mental impairment is observed not only in preschool children, but also in a similar proportion of school-age children. One of the main problems among Latin American schoolchildren is the high percentage of dropouts: of 100 children who begin primary school, only 20 finish. This high dropout rate is probably due in part to learning difficulties and low mental performance.

During the past year we planned and carried out a study in a rural public school near Santiago, Chile. It was located in a poor, relatively homogeneous agricultural zone in which almost every father was a tenant farmer who did not own land. One hundred and sixty-six children were studied. They constituted a sample taken at random from the school's 800 students, whose ages ranged from six to 13 years. The following parameters were studied: (1) anthropometry and clinical signs of nutritional status; (2) the nutritional characteristics of each child and his family; (3) the socioeconomic characteristics of the family that defined life conditions and the sociocultural environment; (4) the child's school performance (in order to make an estimate of the amount of knowledge he had assimilated); and (5) the child's intelligence quotient, obtained through the infantile Wechsler intelligence test.

The complete data are now being processed, but preliminary results indicate a high incidence of undernutrition and low mental performance. Table 1 shows some data for the different years of primary education. The number of students enrolled is high during the first and second years but decreases thereafter because of dropouts.

During the first two years children had an average height deficit, in relation to age, of 10 per cent (compared to the Iowa Scale's 50th percentile). In later school years this deficit was only 3 per cent. The same thing can be seen as regards weight–the first years showed a deficit of 15 per cent and the later ones only 3 per cent. The intelligence quotient was low during the first and second years and increased during the following years, reaching an average value of 101 in the seventh and eighth years. Something similar happened with school performance, which increased significantly during the later years.

For the same group of children we developed a "cultural deprivation" index in which the following parameters were considered: education of the mother and father, IQ of the mother, and family access to mass media (television, radio, newspapers, and magazines). Significant correlations were observed between intelligence quotient and the degree of cultural deprivation ($p < .01$), growth retardation ($p < .05$), and consumption of minimal proteins ($p < .01$).

We are now studying the group of children who left school prematurely; even though we

TABLE 1–Nutritional, physical, and intellectual correlates of children in the Alto Jahuel Primary School near Santiago, Chile.

School year	1st/2nd	3rd/4th	5th/6th	7th/8th
Number of students	403	260	160	80
Height deficit for age (avg.)	10%	7%	7%	3%
Weight deficit for age (avg.)	15%	8%	9%	3%
Caloric deficit for age (avg.)	16%	10%	10%	+2%
Animal protein deficit for age (avg.)	32%	20%	17%	6%
IQ (Wisconsin) (avg.)	81	87	92	101
School performance	50	57	60	66

TABLE 2—Intelligence quotient, weight, and height of 60 schoolchildren (7 to 9 years old) during a nine-month period.

Period of study:	Month 0	Month 4	Month 9
Normal IQ (Gille) (> 91)	9%	11%	8%
Subnormal IQ (Gille) (80-89)	50%	44%	48%
Deficient IQ (Gille) (< 79)	41%	45%	44%
Total weight increase (avg.)	0	1.8 kg	2.7 kg
Total height increase (avg.)	0	2.3 cm	4.1 cm

have no definite results, it seems clear that these dropouts had a lower intelligence quotient than children of the same age who continued in school.

All these observations seem to indicate that the low intellectual performance so frequently observed in the poor seriously interferes with school performance and probably determines whether a child drops out. However, from the data so far analyzed we cannot conclude the degree to which undernutrition or cultural deprivation influences mental development.

Two years ago we tried to see if a schoolchild's low intellectual performance could be modified by appropriate feeding. With this object we chose 60 poor children seven to nine years old who were small for their age. They received three meals at school that were adequate for their total food requirements. The trial lasted all nine school months; the children's intelligence quotients were measured at the beginning, at the fourth month, and at the end of the trial (Table 2).

During this period a normal increase in weight and height could be observed, but there was no change in the high frequency of intellectual deficiency. Even though the observation period was relatively short, it would appear that adequate nutrition during the early school years did not improve intellectual capacity. It may be postulated that the psychological deficit is due mainly to factors other than nutritional ones (e.g., sociocultural factors), or that irreversible damage is produced by undernutrition before this time.

A very interesting experiment with preschool children is now taking place in Cali, Colombia, under the supervision of Dr. Leonardo Sinisterra and Drs. Harrison and Arlene McKay (I have participated as a consultant). Three-year-old undernourished children from a slum area of the city have been selected and enrolled in a program of physical and cognitive stimulation that also keeps them adequately fed. As a control, another group of three-year-olds with the same nutritive and socioeconomic status have been receiving an adequate diet at home without special stimulation. After only one year of operation the results seem clear. While both groups have gained physically according to the norm, only the stimulated group has improved significantly in intellectual development; however, by the end of one year the stimulated group had achieved values very similar to those of Colombian middle-class preschool children. This indicates that the impairment of mental development may be reversible at this age, though feeding alone is not sufficient to increase such mental development—at least not in a period of only one year.

Of all the factors analyzed, it seems obvious that the poor intellectual performance observed in low socioeconomic groups cannot be attributed only to malnutrition, but must also be ascribed largely to sociocultural factors that interfere with adequate stimulation during the first years of life. Malnutrition is never an isolated phenomenon, and it is almost impossible to analyze separately each factor's contribution to intellectual retardation so as to obtain a definite answer. The important thing to know is not so much the workings of the mechanism that produces mental impairment, but the fact that this mechanism really exists and that it interferes very severely with the individual's development—and therefore with society's development. Poor intellectual performance interferes with learning processes and

education in general, preventing children from reaching adequate educational and cultural levels, and thus preventing them from being wholly incorporated into the socioeconomic development of their countries.

It may also be concluded that it is too late to correct mental impairment beyond seven years of age. Neither adequate feeding nor conventional education improves mental performance in any important way after that time. However, very good results seem to be obtained if stimulation and adequate nutrition start during the first three years of life.

An inadequate environment, from a sociocultural as well as a nutritional viewpoint, evidently lessens the child's developmental possibilities when he enters school, so that good performances during the school years are very difficult to obtain.

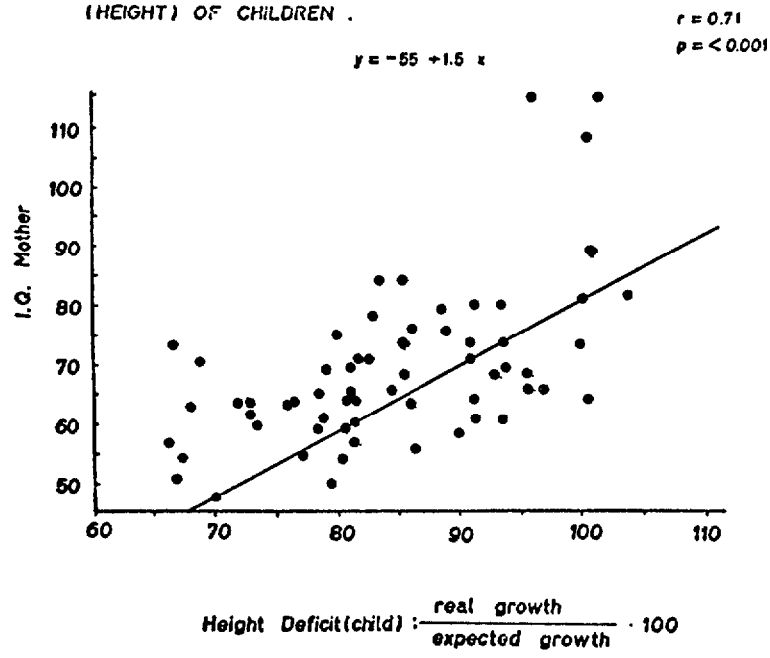
It seems evident that programs of stimulation and education should start during the first years of life, so that the child may later perform adequately in school. Nevertheless, we must recognize that an adverse environment is a very difficult obstacle to overcome. We have measured the intellectual quotient of mothers in different slum areas in Santiago and have found a high frequency of mental retardation (Table 3). Seventy per cent of the mothers had an IQ under 79, according to results of the Terman-Merril test; middle-class mothers showed much higher IQs, none of them scoring below 79.

TABLE 3–Intelligence quotients of slum-area and middle-class mothers.

	Slum area (%)	Middle class (%)
Normal (>91)	6	96
Subnormal (80-89)	17	4
Deficient (<79)	77	0

A very close relationship was observed between the mother's IQ and the growth status of her children ($p < .001$) (Figure 4): the lower her IQ, the worse the nutritional status of the child. This fact is extremely important and shows that a correlation exists between inadequate cultural environment and nutrition.

FIGURE 4–Intellectual quotient of mothers (Wechsler-Bellevue scale) and growth (height) of children; ($r = 0.71$, $p < 0.001$).



This is a vicious circle that explains why mental impairment persists from one generation to another and offers very few possibilities for the individual to escape. The only solution is to create a new and different environment for the child in which he may receive appropriate stimulation, education, and nutrition from the first years of life. More research is needed in this field, but given present knowledge it seems that this is the only way to really get to the heart of the problem and obtain rapid changes from one generation to the next.

SUMMARY

It has been confirmed that severe undernutrition in early life delays brain development. However, the effect of chronic undernutrition on mental development during the preschool and primary school years is less clear.

Recent studies of Chilean schoolchildren from poor families point toward significant relationships between the children's intelligence quotients and their relative cultural deprivation, growth retardation, and consumption of proteins. Other research indicates that adequate nutrition, by itself, does not imply any improvement in intellectual capacity.

Controlled studies with Colombian preschool children suggest that lack of stimulation can play a determining role in mental development. Slum children given an adequate diet plus special physical and cognitive stimulation showed marked intellectual improvement after one year. Another group that received an adequate diet but no special stimulation failed to improve in comparison to undernourished groups.

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