LONGITUDINAL STUDIES ON THE EFFECTS OF MALNUTRITION, NUTRITIONAL SUPPLEMENTATION, AND BEHAVIORAL STIMULATION

Josef Brožek, D. B. Coursin, and M. S. Read

Six longitudinal Western Hemisphere studies on malnutrition and child development are making important contributions to human knowledge. Some time ago, a meeting was held at Cali, Colombia, to help compare these studies and to obtain an overview of available results. The review published here provides a summary account of information presented at that meeting.

Introduction

Malnutrition of the protein-energy variety, aggravated by infectious diseases and parasitism, is a serious health hazard in poor, industrially underdeveloped countries. The problem attracted added attention from the international research community in the mid-1950's when the data began to suggest that severe childhood deficiency of protein and/or calories resulted not only in the wasting of body tissues (extreme cases resulting in nutritional marasmus) and retardation of physical growth (stunting), but also in retarded behavioral development.

Unfortunately, the problem proved considerably more complex than it had initially appeared, so that even now, some twenty years later, there are still gaps in the information needed for policy development and policy decisions. Fortunately, important contributions to our knowledge are and will be forthcoming from several longitudinal studies being carried out in the Western Hemisphere, using a wide array of methods.

A large body of data is being generated by these projects which relates to pregnancy outcomes and to the health, physical growth, and mental development of children studied under different nutritional and environmental conditions, with or without nutritional supplementation and behavioral-educational stimulation.

It is becoming increasingly important
that cooperative arrangements be established between these projects so as to facilitate cross-validation of their observations and conclusions, as well as joint project analyses especially with regard to questions for which data from more than one project are needed.

The Cali Conference

For some time the need has been felt to clarify similarities and differences in the research design and methodology of major longitudinal studies on the effects of chronic marginal or deficient nutrition, nutritional supplementation, and behavioral stimulation—and also to obtain an overview of these studies' available results. Efforts by the Committee on Nutrition, Brain Development, and Behavior to satisfy this need led to an international meeting at Cali, Colombia, on 20-24 October 1975.

At the opening session Miguel Urrutia, Director of the Colombian Department of Planning (Departamento Nacional de Planeación), voiced the pressing need of his office, and of national planners in other developing nations, for valid scientific evidence regarding the social costs of different degrees of malnutrition and the comparative benefits to be expected from investment of limited funds in different activities—such as provision of school lunches vs. provision of food supplements to pregnant mothers and young children. Questions of this kind are political problems rarely considered by nutritional scientists. But while the questions themselves are deceptively simple, acquisition of evidence on which governmental decisions and choices can be dependably based is exasperatingly complex and difficult.

Staff members representing all the major Latin American longitudinal studies and one U.S. study, as well as members of the Committee on Nutrition, Brain Development, and Behavior, took part in the Cali meeting. In all, the following agencies and projects listed alphabetically by city, country, agency, and responsible investigators—were represented:

1) Bogotá, Colombia; Colombian Institute of Family Welfare (Instituto Colombiano de Bienestar Familiar); J. O. Mora and M. Guillermo Herrera.

The investigation, being carried out among a poor urban population with a high risk of child malnutrition, is focused on the impact of nutritional supplementation on child development. Different subgroups begin receiving the supplement at different times during pregnancy or infancy and continue receiving it for up to three years. Some subgroups receive behavioral stimulation as well.

2) Cali, Colombia; Human Ecology Research Station (Fundación de Investigaciones de Ecología Humana); Harrison E. McKay, Leonardo Sinisterra, and Arlene McKay.

The study, being carried out among a poor urban high-risk population of preschool children, deals with the developmental effects of nutritional supplementation, with or without educational stimulation. The children in the preschool phase of the project range from three to six years of age.

3) Guatemala City, Guatemala; Institute of Nutrition of Central America and Panama (INCAP); Robert E. Klein.

This nutritional intervention study of child development is being conducted in rural Guatemalan villages. Nutritional supplementation has been initiated in pregnancy or at various ages up to seven years.

4) Mexico City, Mexico; National Institute of Nutrition (Instituto Nacional de Nutrición); Adolfo Chávez.
This project is exploring the impact on child development of nutritional supplementation during pregnancy, lactation, and childhood up to five years of age. The study, which involves an additional two-year follow-up period, is being conducted among residents of a small Mexican village.

5) Mexico City, Mexico; Children's Hospital, Mexican Institute of Child Welfare (Hospital del Niño, Institución Mexicana de Asistencia a la Niñez); Joaquín Cravioto and Elsa DeLicardie.

This ecological study, carried out in a semi-rural town, deals with the effects of environmental stresses and naturally occurring variations in nutritional status on the development of children from birth to seven years of age.

6) New York City (Harlem), United States; Columbia University School of Public Health, Division of Epidemiology; David Rush, Zena Stein, and Mervyn Susser.

Focusing on a high-risk Black urban population, the investigators have studied the influence that nutritional supplementation during pregnancy can have on the offspring at birth, during infancy, and, selectively, through the first four years of life.

Periods Covered

The starting dates of the projects and the estimated or actual terminal dates for data collection, data analysis, and preparation of a final report or monographic presentation are given in Table 1.

Research Design

For each project, periods of observation without nutritional supplementation, with nutritional supplementation, and with nutritional supplementation plus behavioral stimulation are indicated in Figure 1. For purposes of simplification, however, some project features are not shown. In Cali, Colombia, parallel control groups (which received supplementation without stimulation) are not included. Likewise, the fact that mothers in the Guatemala and Mexico (Chávez) projects received supplements during lactation is not represented. In addition, the New York project provided women in the study with two dietary treatments during pregnancy; it also employed a control group that received routine obstetric care, including provision of vitamins and minerals.

Populations, Home Diets, Supplements, and Behavioral Stimuli

For each of the six projects, the size and nature of the population under study, the home diet before supplementation, the stimulation provided, and the composition, daily intake, and timing of nutritional supplements are as indicated:

1) Bogotá, Colombia

Population: A total of 456 families were enrolled, beginning in March 1973 and ending in October 1974; as of 1976 the number of participating families was 388. Study children were selected before birth from mothers who were in the second trimester of pregnancy and who had at least one preschool child that was well under norms established for its age group—less than 85 per cent normal weight and less than 95 per cent normal height (Colombia norms), and below the third percentile of the Harvard height norms. The mean birth-weight of this study population is not known; for a similar group, the mean birth-weight was 2.9 kg. Mothers smoked very little. The participating population consisted of poor urban dwellers with an average family income of US$35 per month. Most of the parents involved have lived in Bogotá for five years or more and were de-
Table 1. Starting dates of projects and dates set for completion of data collection, data analysis, and document preparation.

<table>
<thead>
<tr>
<th>Locality (and starting date)</th>
<th>Completion of data collection</th>
<th>Completion of data analysis</th>
<th>Completion of final report or monograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Bogotá, Colombia (1975)</td>
<td>June 1978</td>
<td>1978 to 1980</td>
<td>Several monographs planned, dates not yet specified</td>
</tr>
<tr>
<td>3) Guatemala City, Guatemala (1969)</td>
<td>1977</td>
<td>1978 to 1979</td>
<td>A series of articles and monographs is to be completed by 1979</td>
</tr>
<tr>
<td>5) Mexico City, Mexico (Cravioto, 1966)</td>
<td>Completed</td>
<td>Probably by the end of 1978</td>
<td>A monograph on severe malnutrition is to be done by December 1977 Other monographs are to be written during 1977-1979</td>
</tr>
<tr>
<td></td>
<td>Data on one-year-olds, April 1975;</td>
<td>Fall 1976</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selected follow-up, April 1976</td>
<td>Probably in 1977</td>
<td></td>
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</table>

Figure 1. Periods of observation without nutritional supplementation (ooooo), with nutritional supplementation (+ + + +), and with nutritional supplementation plus behavioral stimulation (+ x + x); each symbol represents 1.5 months.
scended from highland Indians. Health care for the study population has been provided through a health center and bi-weekly home visits.

**Home diet:** A 24-hour dietary recall during the sixth and eighth months of pregnancy indicated a maternal home diet of 1,600 calories and 35 g protein with no change during pregnancy.

**Supplement (composition):** Powdered skim milk, 60 g per capita; enriched bread, 150 g for pregnant mothers and 75 g for other family members; vegetable oil, 20 g per capita; minerals and vitamins for pregnant mothers.

**Supplement (daily intake):** This has been provided at the health center to take home. Pregnant mothers have received supplement containing about 800 calories and 38 g protein. There has been considerable substitution, so that each mother's effective average dietary increase has amounted to about 200 calories and 20 g protein per day. The increased dietary intake of children has not been estimated. Dietary surveys were conducted at 18 and 36 months.

**Supplement (times provided):** Three subgroups have been receiving the supplement—from the mother's sixth month of pregnancy to the child's sixth month of life, from the mother's sixth month of pregnancy to the child's thirty-sixth month of life, and from the child's sixth month of life to its thirty-sixth month of life.

**Stimulation:** A special weekly effort has been made to teach mothers how to use household articles to provide their children with play-like learning experiences.

2) Cali, Colombia

**Population:** Three hundred three-year-olds were selected in 1970 from among 800 families (out of a total pool of 8,000). These were the children with the lowest heights and weights for their age group; they were below the third percentile of the Harvard height norms and below the tenth percentile of the Harvard weight norms. The subjects came from a poor urban population with very low income, little tendency to migrate, and an average family size of 7.5 persons. Not including 52 upper-class control subjects, the number of children in the sample in 1974 was 263. Health care has been provided for these children at a health center.

**Home diet:** No specific data are available on the home intakes of children fed at the health center, or on those who received their supplement at home.

**Supplement (composition):** Children fed at the center have received mixed food plus "Colombiharina" (a variant of INCAPARINA made from soya and rice and containing 19 per cent protein). The project's goal is to provide 100 per cent of their protein needs and 80 per cent of their caloric needs at the center. The children are fed in groups, and are allotted 1 to 1.5 g of protein per kg of body-weight. Children fed at home have received prepared World Food Program packages with no indigenous foods.

**Supplement (daily intake):** A record has been kept of the daily intake of individual children fed at the center. For children fed at home, family members came to the center to pick up sufficient supplement for the whole family. A home visitor then recovered the empty containers once a week as a check on consumption. There are no data on individual children's intake.

**Supplement (times provided):** Different groups of children entered the program at three, four, and five years of age.

**Stimulation:** School provided the setting for a cognitively oriented educational program.

3) Guatemala

**Population:** Two sample groups were studied. One, a cross-sectional sample, included 1,550 children at or below seven years of age in 1969. The other, a longitu-
Some of the activities being performed by the longitudinal projects
described—Food supplementation at a rural village center (top left), and
three of the techniques used to measure the effects of nutrition programs:
maternal anthropometry (top right), wrist X-ray (bottom left), and psychological
testing (bottom right). (Photos: PAHO/INCAP).
dinal sample, included only children born in 1969-1973; the number of subjects in this sample at birth (including stillborns) was 671. The study was carried out at four isolated rural villages whose residents depended on subsistence farming and who had an average family income of US$200 per year. The average family size was 6.5 members, the mother's average height was 149 cm, and the children's average birth-weight was 3.0 kg. Health care was provided through a health center and bi-weekly home visits.

**Home diet:** On the average, mothers received about 1,650 calories and 45 g protein per day before pregnancy, and there was no change during pregnancy.

**Supplement (composition):** Two villages received “Atole,” a beverage containing about 160 calories and 11 g protein per cup, plus vitamins and minerals. Two other villages received “Fresco,” a beverage containing some 60 calories (but no protein) per cup, plus vitamins and minerals.

**Supplement (intake):** Health centers provided Atole (or Fresco) upon request to anybody in the villages under study. The average daily supplement intake for pregnant women was 135 calories, plus 9.1 g of protein for the group receiving Atole. The average intake for children was estimated at 10 calories per kilogram of body weight per day at about 18 months of age. Subsequent calorie intake increased with increases in age and body size. Individual intake of supplement was recorded for pregnant and lactating women and for children up to their seventh birthday. The supplements had very little effect upon customary home food consumption.

**Supplement (times provided):** Supplement was provided to mothers early in pregnancy, as soon as they chose to come to the centers. Children were given supplement as early as the mothers brought them, usually at nine months of age or later.

**Stimulation:** None.

4) **Mexico (Chávez)**

**Population:** One group, which received no supplement, consisted initially of 20 pregnant women selected in 1968 from mothers in 40 families. These women were in the middle height range (136-152 cm) and had been expecting their second, third, fourth, or fifth child. Normal birth and a birth-weight of 2.5 kg or more were the criteria for selecting mother-infant pairs for follow-up. The average birth-weight was 2.7 kg.

Another group, which received supplement, consisted initially of 20 pregnant women selected from 40 families in 1970 using the same criteria as above. Six pairs of children in control or experimental groups are siblings. At present, N = 17 in each group due to deaths or to families moving away. The subjects resided in an isolated rural village with a stable homogenous population that followed traditional child-rearing practices. Family income was low, averaging US$45 to US$60 per month. The average number of people in each family was 7.2. Health care was provided through a health center and frequent home visits.

**Home diets:** A 24-hour dietary recall at eight months of pregnancy indicated an average daily intake of 1,835 calories and 42 g protein. Dietary changes during pregnancy, if any, are not known. A dietary recall was carried out during the sixth month of lactation.

**Supplement (composition):** Partly-skimmed milk (for the mothers), plus minerals.

**Supplement (daily intake):** Mothers were given two or three glasses of the milk per day. This was consumed in the presence of a home visitor, who recorded the intake. Each serving contained 120 calories and 9 g protein, and the number of servings increased from early pregnancy through lactation. The average daily supplement consumption during pregnancy was 205 calories and 15 g protein; during lactation this rose to 305 calories and 23 g protein.
Children were offered one bottle of full-fat milk a day beginning at three months of age, and the amount provided was gradually increased. Breast-milk consumption was measured by determining the change in the infant's weight before and after feeding. This was done for a 72-hour period on nine occasions as the children went from two to 36 months of age. Intake of other foods was also registered during these 72-hour dietary survey periods. The calorie and protein intakes of the children varied with age. Estimates of these intakes are available.

Supplement (times provided): Supplement was provided to mothers from about the forty-fifth day of pregnancy through lactation, and to children from three months through five years of age.

Stimulation: None.

5) Mexico (Cravioto)

Population: The 307 subjects studied were born in calendar year 1966; of these, 209 remained under study for seven years. Maternal ages, weights, and heights ranged from 13 to 43 years, 32 to 82 kg, and 133 to 165 cm. The children's average birth weight was 2,860 g (± 408 g) for girls, 2,977 g (± 394 g) for boys.

Regarding maternal education, 46.4 per cent of the mothers were illiterate, 9.8 per cent could read or had completed one year of school, 36.1 per cent had attended school for two to five years, and 1.5 per cent had received between seven and 13 years of formal schooling. Among the literate mothers, 16.3 per cent read newspapers, 52.9 per cent listened to the radio, and 9.8 per cent watched television. On a scale of 0 to 100, home sanitary conditions for the population studied were accorded a median rating of 24.

The principal providers of income for the cohort were agricultural workers (66 per cent), industrial workers or craftsmen (16 per cent), and merchants or professionals (4.6 per cent). The remaining 13.4 per cent of the providers were listed as home workers, being either casual workers, mothers receiving pensions who did only housework, or male pensioners. Of the agricultural workers, 75.0 per cent were wage laborers, 13.5 per cent worked a family plot, and 7.0 per cent rented their land.

The annual average per capita income of each family member was US$174.04, individual family incomes ranging from $37.41 per capita to $1,783.52. Family size (the number of people comprising each family) averaged 7.0 persons, the smallest quarter in the cohort averaging 5.0 persons and the largest quarter averaging 9.0.

Health care was available at a health center.

Home diet: Dietary surveys and observations of home food consumption were made regularly; data on average intakes are available.

Supplement: None.
Stimulation: None.

6) New York, U.S.A.

Population: A total of 1,051 Black, English-speaking pregnant women from Harlem were enrolled in 1970-1973. Of these, 814 were participating when their children were born and 523 were participating in 1972. Criteria for selection were a low pre-pregnancy weight (under 49.9 kg), or else a weight of 49.9-63.5 kg combined with (a) low weight-gain in pregnancy, (b) a previous infant with low birth-weight, or (c) a 24-hour protein intake of less than 50 g. No alcoholics or drug users were included. The mean maternal height, weight, and age were 159.8 cm, 52.6 kg, and 22 years. Maternal ages ranged from 15 to 35 years. Forty-three per cent of the mothers smoked. The mean birth-weight for Harlem Blacks was 3,100 g, but the mean birth-weight of this sample was 2,974 g. Seventy-one per cent of the mothers were unmarried; two-
thirds had at least 11 years of schooling. Family incomes were low but variable; 25 per cent of the mothers were on welfare at recruitment, but many more would qualify with the birth of the child. Health care was provided through hospital outpatient services.

**Home diet:** Initial values at recruitment were 1,798 calories and 65 g protein per day, but low intake was a selection criterion: later values were higher.

**Supplement (composition):** A "supplement" group received 470 calories and 40 g protein per day, together with minerals and vitamins. A "complement" group received 320 calories and 6 g protein per day, plus minerals and vitamins. A "control" group received vitamin tablets. Regular obstetric care was available to all groups.

**Supplement (daily intake):** The supplement and complement groups were provided with a monthly supply of two cans of supplement per day, delivered to their homes. Can counts and monthly reports indicated 70 to 75 per cent consumption. Added to the mothers' base diet, this brought the average daily intake of the "supplement" group to 2,341 calories and 108 g protein, and that of the complement group to 2,283 calories and 83 g protein. The average daily intake of the "control" group was 2,065 calories and 81 g protein.

**Supplement (times provided):** Mothers were enrolled during the first or second trimester of pregnancy; the mean gestation age at registry was 17 weeks; no supplement was provided postnatally to either the mother or her infant.

**Stimulation:** None.

### Methods and Measurements

The information available is too extensive to provide here, so only broad categories of methods and measurements are described.

1) **Bogotá, Colombia**

A wide array of biomedical data were collected concerning pregnancy, diet, morbidity, biochemistry, anthropometry, and neurological findings. Psychological observations and measurements of responses by neonates, infants, and children were made at varying intervals, in some cases up to 36 months of age. Infant-caregiver interactions were observed at home and in the laboratory, and a home interview was conducted with the mother (Cf. Mora, et al. — 1).

2) **Cali, Colombia**

Data were obtained from detailed anthropometry, clinical examinations, and hematological analysis. Extensive coverage was given to psychological variables by means of standardized intelligence tests (Stanford-Binet and Wechsler intelligence scales), single-task tests (Raven Matrices), the Piagetian (Montreal) test battery, a variety of locally adapted and locally developed tests, behavioral rating scales of affective responses, assessment of socioeconomic status, teachers' and parents' behavioral observations, and teachers' ratings (Cf. McKay, McKay, and Sinisterra—2).

3) **Guatemala**

Both maternal and child biomedical variables are measured. For the children, data is collected through anthropometry, determination of urca/cratinic ratios, morbidity data, and clinical, pediatric, and neurologic examinations. For the mothers, six categories of data are collected—from prenatal examinations, body measurements, morbidity surveys, home dietary intakes, supplement consumption, and family socioeconomic status. Special studies have been made of the infants' consumption of mothers' milk. Psychological performance is measured in terms of several test batteries
appropriate for children at different age levels—including neonates, infants, and preschool children. An attempt has been made to relate these psychological test data to school performance and to the community's perception of a child's intelligence (listura). Background data include information on the socioeconomic status of the families (Cf. Klein, et al.—3).

4) Mexico (Chávez)

The mother's nutritional status is assessed during the eighth month of pregnancy and at the sixth month post-partum by means of a 24-hour record of food consumption, a clinical examination, anthropometry, and determination of hemoglobin levels. Socioeconomic evaluation of the family and an analysis of ecological factors is performed several times during the study; a follow up, initially planned for children up to six years of age, was subsequently extended to age seven.

In addition to the common procedures (anthropometry, clinical examinations, neurological evaluations, and morbidity assessments), the children were photographed and their food consumption over 72 hours was measured periodically. Not only were the Gesell Developmental Scales administered regularly, but records of the children's physical activity were also obtained. The children were observed in a standardized open-field test, and mother-child interactions were studied by means of a time-sampling procedure (Cf. Chávez and Martínez—4).

5) Mexico (Cravioto)

The extensive measurements made can be grouped into the following categories: familial and parental data of a socio-cultural, environmental, and biological nature, including the parents' height, weight, age, and reproductive history; health data, including prenatal and delivery history, results of pediatric examinations, and the morbidity record of the child and household members; nutritional data, including patterns of food consumption by the child and the family and clinical evaluation of the child's nutritional status; physical growth data, including bone age; mental growth data, including measurements of the psychomotor, adaptive, language, and social-personal development of the child, the Wechsler's intelligence scale appropriate for the age, and a number of special measures of mental development showing differences in response to cognitive demands, sensory-motor skills, and language development (Cf. Cravioto and DeLicardie—5).

6) New York, U.S.A.

The following activities were carried out in order to collect data on the mothers during pregnancy: a detailed socioeconomic questionnaire was completed, three 24-hour diet recalls were conducted, and various tests and examinations were performed—including analyses of blood and urine, determinations of body weight and blood pressure, and general obstetric examinations. Newborns were subjected to body measurements, a neurological evaluation, and a psychodevelopmental assessment (i.e. a structured observation of behavior, activity level, habituation to acoustic and tactile stimuli, and visual pursuit). Later, upon reaching 44 weeks of age, the infants were given another neurological examination, together with a psychodevelopmental assessment that involved an object permanence test, habituation to visual stimuli, open-field play, and mother-child interaction (Cf. Rush, et al.—6).

General Conclusions

Only partial and, in some instances, preliminary results from these projects are at
Tentatively, however, the following conclusions may be reached:

**Birth-weight**

The mother's nutritional status influences birth-weight. There is some evidence that birth-weight can be increased by nutritional supplements, though this finding is not universal, and the nutrients that will be effective in this regard probably depend upon the specific situation. Energy shortages seem directly implicated as a cause of low birth-weight in certain areas, but there is also evidence suggesting that proteins may be involved in other regions. Moreover, a number of environmental and socioeconomic factors are correlated with birth-weight, and these must be controlled before a complete understanding of factors accounting for low birth-weight can be attained.

**Child Growth**

Nutritional supplementation of young malnourished children increases their rates of growth, but there is probably no true catch-up growth that will bring them to the accepted norms for their age groups, even though their gain in height may parallel that of more favored populations.

**Behavior**

It has been reported that child behavior is positively affected by nutritional supplementation of the undernourished mother during pregnancy and following delivery, and by supplementation of the undernourished child. More definitive conclusions on this point must await completion of several of the studies. At the present time, it appears that the earlier the supplementation begins, the more likely a positive outcome.

Thus far, those positive effects of nutritional supplementation that have been reported tend to be more definite for motor functions than for cognitive functions, especially in younger children. However, these reports are not consistent enough to give one full confidence in the findings. In this regard, it must be noted that behavioral outcomes interact in important and complex ways with the family's socioeconomic condition and the social stimulation available to the child.

**Beyond the Cali Conference**

The Cali meeting was a "first" in terms of exchanging scientific information about research in progress bearing on the effects of malnutrition on human behavior. Not only did it permit broad and detailed examination of the subject, but it also opened the door to pooling of information across projects. It is hoped that this will prove to be only the beginning, and that it will be followed by various kinds of endeavors, including the following:

1) Collaborative activities, limited in scope and in the number or participating individuals, that are designed for purposes such as modeling of nutritional status.

2) Joint exploration of major technical issues, especially ones involving methodology.

3) Critical assessment of the findings of the longitudinal studies, together with evaluation of the practical implications of the collected data.

The administrative mechanisms supporting cooperation are flexible and can involve varying numbers of individuals and research teams. Potential forms of collaboration discussed at the meeting included exchanges of data and personnel, re-examination of a body of data using common methods of analysis, adoption of a given project feature by other projects, and creation of workshops focused on relatively narrow specific topics such as particular analytical techniques or methodological
problems. Some collaborative measures along these lines may be implemented fairly soon, especially if they involve a limited number of individuals or projects and can rely largely on correspondence for exchanges of information. Other efforts will need workshops involving a number of projects, often with invited consultants in specific disciplines; such consultants may also be needed by individual projects seeking to implement collaborative measures.

All participants at the Cali meeting agreed to provide the Committee on Nutrition, Brain Development, and Behavior with copies of correspondence and plans relating to collaborative activities in order to avoid duplication of effort.

The Chairman underscored the growing trend toward large-scale interventions involving difficult and critical problems of evaluation. This theme was further developed by Sol Chaifkin, Vice-President of the Ford Foundation. He noted that we have to ask not only what is replicable in investigations on nutrition and behavior, but also what is applicable, and which components of the intervention programs provide which benefits at what cost. This information is urgently needed by governments which must make concrete decisions regarding large scale measures designed to improve the quality of life in their countries. Thus the meeting closed on a note sounded in the introductory statement by Miguel Urrutia, who had pointed out the growing concern about the implications of “basic” research for social policies and planning.

**APPENDIX**

Some of the specific tasks and potential topics for inter-study collaboration that were brought up at the meeting are listed below:

**General Matters**

(a) There is a need for agreement on the indicators, terminology, and procedures for describing nutritional status—including anthropometry, dietary surveys, intake measurement, and substitution, within the context of longitudinal field studies.

(b) It is important to clarify and further develop research designs and strategies for the analysis of data generated by longitudinal multidisciplinary investigations.

(c) There is a need to assess the policy implications of the available information on malnutrition, food supplementation, and behavior stimulation, and to obtain formulations of further applied research needs.

**Birth-weights**

(a) The implications of birth-weight for infant mortality, child health, and development should be clearly defined.

(b) The effects of maternal nutritional supplement on birth-weight should be determined, especially with regard to the times when supplement is provided.

**Physical Growth**

(a) The impacts of infection and inadequate nutrition on child growth need to be quantified.

(b) It is important to determine the relative effectiveness of prenatal versus postnatal supplementation on child growth.

**Behavioral Development**

(a) There is a need to define those areas of cognition and behavior most vulnerable to
nutritional insult at various points in a child’s development.

(b) Likewise, it is important to delineate mechanisms of nutritional insult and recovery with regard to behavioral development.

(c) We also need to know the ultimate functional significance of the behavioral effects of deficient nutrition and nutritional supplementation, with particular reference to school performance, real-life competence, and family structure and function.

(d) Analysis of the complex interaction between “stimulation” and nutrition is also required, in terms of well-defined inputs, outcomes, and action mechanisms.

ACKNOWLEDGMENTS

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SUMMARY

Six major Western Hemisphere longitudinal studies of malnutrition and development are in their final stages. These studies are taking place in Colombia, Guatemala, Mexico, and the United States. As a step toward synthesis of the results, a conference was held at Cali, Colombia, with the aim of clarifying differences and similarities. The following features of each study were considered: The starting and completion dates; the research design (including scheduled periods of observation and the presence or absence of nutritional supplements and/or stimulation); the populations involved, their home diets, and the specific supplements and stimulation received; procedures and measurements used in the study; and any general conclusions reached. The conference also identified opportunities and needs for exchange of information between projects and for a collaborative approach to such specific problems and topics as birth-weight, physical growth, and behavioral development.

REFERENCES


