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THE EFFECTS OF EARLY NUTRITIONAL INTERVENTION ON HUMAN CAPITAL FORMATION

(Research based on the EASTERN LONGITUDINAL STUDY)

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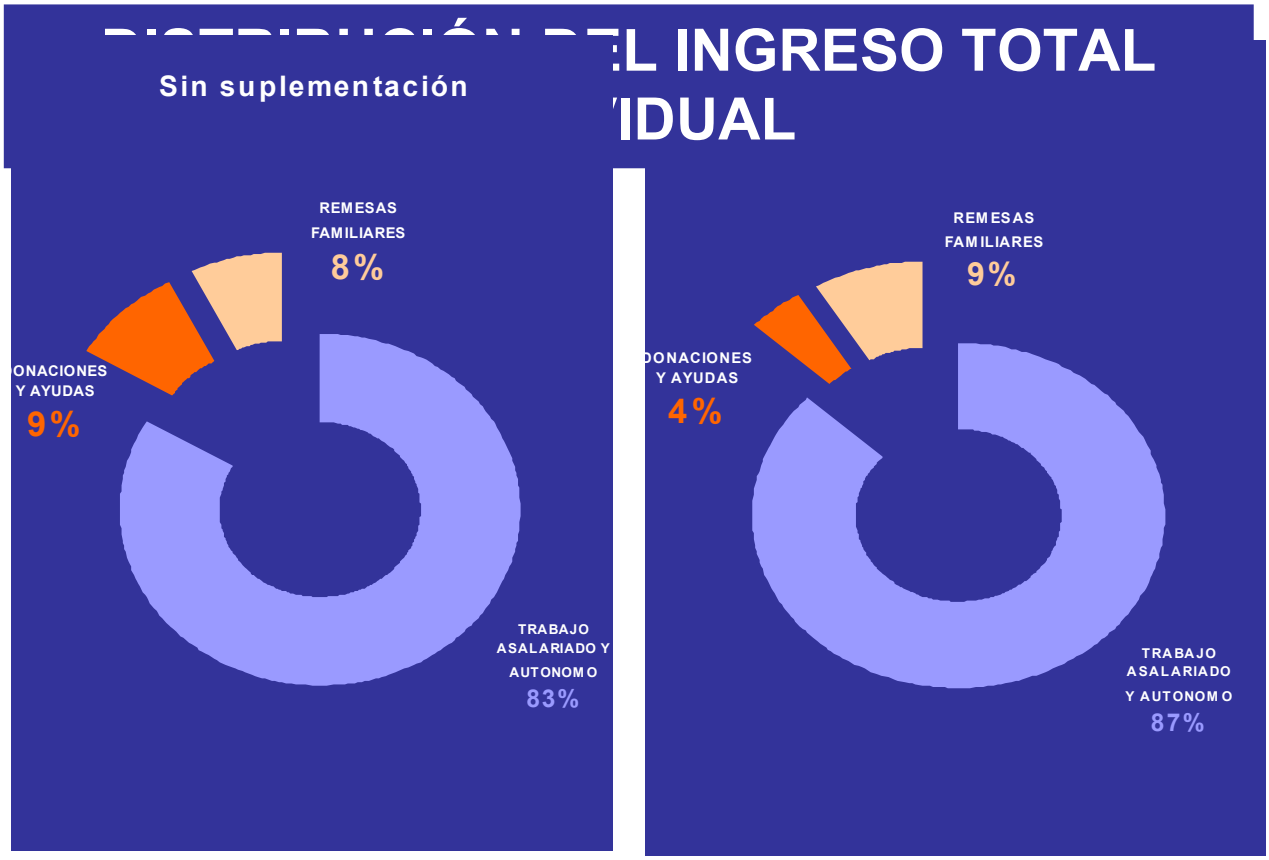

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I. INTRODUCTION

The impact of adequate early nutrition on height, muscle mass, and psychoeducational abilities in adolescent life has already been demonstrated[1,2,3,4] -- findings suggesting that, for societies that make heavy use of manual labor, this impact should be far-reaching and extend into adult life in the form of higher income.

This report presents the results of the cross-sectional study conducted in the second half of 2000, whose objective was to validate that hypothesis and determine the effects of early nutritional supplementation on income levels and well-being in adults, based on the data from the Eastern Longitudinal Study from 1969 to 1977 conducted by the Institute of Nutrition of Central America and Panama (INCAP). The report presents information on the research process in its different stages as well as the results obtained.

To carry out the work, four stages of research were conceived: design, data collection, processing and statistical analysis of the data, and analysis of results. The products of each of them are presented below.

In the final sections of the document, the actual findings as well as recommendations and orientations for future processing of data from the 2000 census and the longitudinal study are summarized.

[1] Galler JR, Ramsey F, Solimano G, Lowell WE. The influence of early malnutrition on subsequent behavioral development. II. Classroom behavior. J Am Acad Child Psychiatry 22: 16-22, 1983

[2] Pollit E, Gorman KS, Engle P, Martorell R and Rivera JA. Early Supplementary Feeding and Cognition Effects Over Two Decades. Monographs of Society for Research in Child Development 1993, Serial No. 235,58 (7): 122 pages.

[3] Behrman JR, Foster A, Rosenzweig MR. The dynamics of agricultural production and the calorie-income relationship: Evidence from Pakistan. J Econometrics 77 (1): 187-207.

[4] Deolalikar AB. Nutrition and labor productivity in agriculture: Estimates for rural South India. RvwEcon Stats 70(3): 406-13,1988

II. BACKGROUND

In 1969 INCAP initiated the Eastern Longitudinal Study in four rural communities in eastern Guatemala. The individuals included in this study—a total of 2,393 in all--participated in a program of protein-energy supplementation (the cases) and energy supplementation (the controls); both groups also received health care. The cases, who received supplements of gruel between 1969 and 1977, were all the children born between 1962 and 1977 in the communities of Conacaste and San Juan, both belonging to the Municipio of Sanarate in the Department of El Progreso. The controls, in turn, who received supplements in the form of a fruit drink between 1969 and 1977, were all the children born between 1962 and 1977 in the communities of Santo Domingo, Municipio of San Antonio La Paz, and Espíritu Santo, Municipio of El Jícaro, both in the Department of El Progreso. The dosages of the supplements received by each study subject, which were offered ad libitum, were controlled during every year of the intervention, which permits us today to categorize the individuals as higher and lower consumers. A more detailed description of this study can be found in the *Journal of Nutrition* (Volume 125, April 1995) and in *Food and Nutrition Bulletin* (Volume 14, September 1992).

Over the years, several cross-sectional studies[5,6,7] have been carried out with the intention of measuring the effects of nutritional supplementation on the anthropometric and health status of these individuals. Some indications of effects on other variables of social development, such as schooling or income, have motivated INCAP to implement this new initiative in an effort to clarify with scientific rigor the causality between the

[5] Martorell R. Results and implications of the INCAP follow up studies. J Nutr 125 (4S): 1127S-1138S, 1995.
[6] Rivera JA, Martorell R, Ruel MT, Habitcht J-P and Haas J. Nutritional supplementation during prescholl years influences body size and composition of Guatemalan adolescents. J Nutr 125 (4S): 1068S-1077S, 1995
[7] Khan A. Schroeder DG, Martorell R and River JA. Age at menarche and nutritional supplementation. J Nutr 125 (4S): 1090S-1096S, 1995.

nutritional and health interventions undertaken in the past and factors of human development, such as the current socioeconomic conditions of these individuals.

III. OBJECTIVES

1. Evaluate the effect of early supplementation on the height of the adult.

2. Evaluate the effect of early supplementation on human capital formation, measured using education, health, and reproductive capacity as variables.

3. Evaluate the effect of early supplementation on the current level of well-being and income of the adults.

IV. STUDY METHODS

1. Design of the Study

This phase of the work was conducted in August and September 2000 and involved personnel specializing in economics and food and nutrition security. The available literature on the Eastern Longitudinal Study was reviewed at the beginning of the 1970s along with the successive cross-sectional studies conducted subsequently as follow-up to the first one.

This review made it possible to identify the information from previous studies that could be utilized as a baseline for current research. The guidelines for the data collection in the year 2000 were developed on that basis. Thus, it was determined that a possible correlation would be sought among:

a) the nutrition and health intervention in children (which occurred between 1969 and 1977).
b) the improvement in human capital in adults (measured using education, health, and reproductive capacity of these people in the year 2000 as variables).
c) the increase in income and well-being in adults in the year 2000.

Given the 25 years that separated the research periods and through a study of cases (children who received supplements of gruel) and controls (children who received a supplement in the form of a fruit drink), it was decided that all comparisons of data done in a search for possible positive effects of supplementation on human capital, income, and well-being would be based on differentials between cases and controls at a single moment in time.

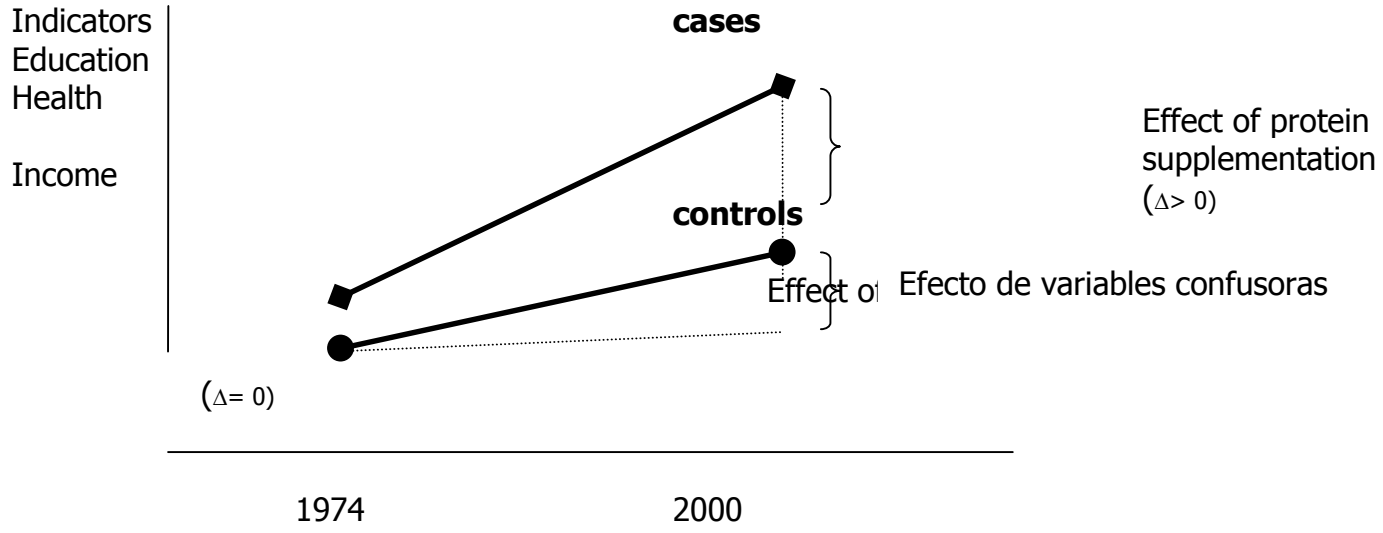
That is, an analysis was designed on the basis of comparisons of the differentials between cases and controls in 1974 and between cases and controls in the year 2000. In this way data from 1974 and the year 2000 were never compared directly. This was done it way since the variables utilized in the study to measure the long-term impact of the nutritional and health intervention on children are development variables that are subject to the influence of a multitude of external factors that have to do with educational, health, and macroeconomic policies in Guatemala in the last 25 years as well as other factors, such as trends in migration. A comparison of educational indicators in absolute terms--for example, between 1974 and 2000--would not have sufficient scientific validity to demonstrate the positive impact of the intervention, since an improvement in human development conditions could be expected in both cases and controls, regardless of the effect of the dietary supplements. Comparison of differentials does have the power to demonstrate the effects of the intervention, inasmuch as confounding variables[8] that would affect cases and controls in a similar manner may possibly be incorporated in the design.

Thus, the study is a comparative analysis of two moments in the lives of the subjects, one in 1974 and the other in 2000. Both moments are framed within given socioeconomic conditions, and it is the comparison of cases and controls at one time that makes it possible to eliminate the influence of these confounding variables on measurements of the impact of supplementation.

The general hypothesis of the study is that, starting from a similar situation in 1974, an improvement can be seen in the variables of development in the year 2000 versus 1974. There has been a general improvement for all the families because of the advances in development in Guatemala, but it is greater in the families of the cases than in those

[8] Confounding variables are understood to be those that, although not the object of the study, determine and affect the study variables. In this study, control of the confounding variables is accomplished by considering them in the design phase.

of the controls. Dosages received and supplementation periods are also considered variables in the comparison of cases and controls.



This approach was applied to the design of research on human capital (education and health) and on income and well-being. It could not be utilized to measure an impact on mortality in view of the fact that the deaths of children in 1974 eliminate the possibility that they could be parents of children whose mortality would be measured in the year 2000. It is for this reason that that analysis will be based only on the search for differences between cases and controls in those years.

For the measurement of **improvement in human capital** (Point b), the following were measured:

1. Education

   1.1 Measurement of the effect of supplementation on the school grade achieved by the children, based on the comparison of the schooling differential between the parents of the children who received supplements (1974) and the schooling differential for the children who received supplements (2000).

Research hypothesis: There are significant positive differences in school grade achieved between cases and controls in the year 2000 (the null hypothesis H_o for that year is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o for that year is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

1.2 Measurement of the effect of supplementation on the degree of literacy attained by the children based on comparison of the differential for literacy among the parents of the children who received supplements (1974) and the differential for schooling among those children who received supplements (2000).

Research hypothesis: There are significant positive differences in the degree of literacy between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

2. Health

2.1 Measurement of the effect of supplementation on height based on the comparison of the height differential among the parents of the children who received supplements (1974) and the height differential among the children who received supplements (2000).

Research hypothesis: There are positive significant differences in height between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

2.2 Measurement of the effect of supplementation on <u>mortality</u> using the mortality differential between the two groups supplemented in their infancy.

Research hypothesis: There are significant negative differences in mortality between cases and controls in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta < 0$

3. Reproductive capacity

3.1 Measurement of the effect of supplementation of the current mothers on the <u>birthweights of their children</u> from the birthweight differential between the children of the two groups supplemented in their infancy (cases and controls).

Research hypothesis: There are positive significant differences between cases and controls in birthweights of the children in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta > 0$

3.2 Measurement of the effect of supplementation of the current mothers on growth retardation in their children (at 12, 24, and 36 months), based on the differential in growth retardation among the children of the two groups supplemented in their infancy (cases and controls).

Research hypothesis: There are significant negative differences in growth retardation between cases and controls in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta < 0$

(** These data were collected from 1996 to 2000.)

3.3 Measurement of the effect of supplementation of current mothers on the mortality of their children, based on the mortality differential among the children of the two groups supplemented in their infancy (cases and controls).

Research hypothesis: There are significant negative differences in child mortality between cases and controls in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta < 0$

For measurement of the effects on **income and well-being** (Point c), the following were defined:

1. Income

1.1 Measurement of the effect of supplementation on the capacity to generate income, based on comparison of the income differential among the parents of the children who received supplements (1974) and the income differential among the children that received supplements (2000). The income is calculated as the sum of income from salaried work, sale and personal consumption of production, gratuities, gifts, pensions, and remittances.

Research hypothesis: There are significant positive differences in capacity to generate income between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ $\quad$ $H_a : \Delta \neq 0$

2000: $H_o : \Delta = 0$ $\quad$ $H_a : \Delta > 0$

1.2 Measurement of the effect of supplementation on the participation of women in the generation of family income, based on comparison of the differential in the percentage of economically active women among the mothers of the children who received supplements (1974) and the differential in the percentage of economically active women among the girls who received supplements (2000).

Research hypothesis: There are significant positive differences in degree of participation of women in economic life between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that

were not detected in their mothers in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

2. Well-being

2.1 Measurement of the effect of supplementation on family well-being, based on comparison of the differential in housing quality among the parents of the children who received supplements (1974) and the differential in housing quality among the children who received supplements (2000). The measure of well-being is based on the possession of housing and the building materials used.

Research hypothesis: There are significant positive differences in degree of participation of women in economic life between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their mothers in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

2. Study Population

The study population comprises the individuals born between 1962 and 1977 and living in Conacaste, San Juan, Santo Domingo, and Espíritu Santo, communities in eastern Guatemala, in the year 2000. These selection criteria group the people who were exposed to the INCAP supplementation program, conducted between 1969 and 1977, a total of 2,393 individuals.

3. Sample Size

Information was gathered using four forms, two of them designed for the general population residing in the communities in the study and the other two for the specific group of individuals that participated in the longitudinal study from 1962 to 1977 and their current families. In the following table, information on the size of the sample obtained from each of them is summarized, at both the family and individual levels. The data presented correspond to the sample sizes that could be utilized in the data analysis, once the clean-up of the data collected in field was finished. The data on individuals obtained from Forms 1 and 3 could be inferred, while the obtained from Forms 2 and 4 ensure the real presence of individuals or families in the communities.

Table 1. Sampling sizes.

	Number of families			**Number of individuals**			**Number of individuals who participated in the 1969-1977 longitudinal study**		
	GRUEL	DRINK	**Total**	GRUEL	DRINK	**Total**	GRUEL	DRINK	**Total**
F01. Census (a)			**1,817**	3,353	3,685	**7,038**	784	749	**1,533**
F02. Housing (a)	787	880	**1,667**	-	-	**-**	-	-	**-**
F03. Socioeconomic (b)	389	400	**789**	-	-	**-**	647	622	**1,269**
F04. Anthropometric (b)	-	-	**-**	1,114	1,159	**2,273**	311	363	**674**

(a) Form used for all inhabitants of the four communities.
(b) Form used for the families of individuals participating in the 1969-1977 study.

4. Study Variables

The independent variable is the degree of caloric and protein supplementation of the individuals participating in the 1962-1977 longitudinal study.

The dependent variables in the study are height, primary and secondary schooling completed, economic income, participation of women in its generation,

and well-being measured in terms of the physical possession of goods in the household.

5. Quality of the Data Collected

The anthropometric measurement of weight and height was done according to Loma et al. The forms utilized were validated and the interviewers trained prior to beginning data collection in the field. All the forms were reviewed before being sent for statistical analysis.

6. Statistical Analysis

The double entry of data in Epi Info 6.0 was used for the receipt of forms, while the analysis was conducted in SAS. For hypothesis testing, Chi-square tests were utilized (in order to compare schooling, degree of literacy, possession of goods, and participation of women in the generation of income), and Student-t, Tukey, and F tests were used in the various comparisons of height and income.

V. DATA COLLECTION

The second work stage was initiated in October and extended to 15 January 2001. The team responsible for this field stage consisted of 12 individuals: a field coordinator, two supervisors, and 10 interviewers.

The first activity was the design of the four forms, which were ready at the beginning of November. This made it possible to begin a two-week period for training staff in their use. At the same time, the forms were corrected and validated in communities similar to those that were the object of study, until satisfactory results were obtained. Data collection in the field was initiated in mid-November and extended over a period of two months.

As mentioned above, four forms were utilized in the data collection: for population census, housing characteristics, income, and anthropometry. Data collection took between one and two hours for each family. A summary of their contents is provided below.

Form 1. Population Census

This form has been utilized in the various cross-sectional follow-up studies conducted in the four eastern communities. It is applied to the entire community and in the 2000 phase it was possible to collect a total of 2,088 forms. The variables included are:

1. Village identification
2. Family identification

3. Identification of all individuals in the family
4. Interview date
5. Marital status of the heads of household
6. Number of pregnancies of the mother
7. Number of live children of the mother
8. Number of deceased children of the mother
9. Number of stillborn infants of the mother
10. Number of miscarriages/abortions of the mother
11. Current religion of the heads of household
12. Previous religion of the heads of household
13. Year that the religion was changed
14. Sex of every individual in the family
15. Full name of each individual
16. Current status of each individual
17. Date of birth of each individual
18. Birth place of each individual
19. Date of death or migration of each individual
20. Ability to read
21. Number of years enrolled in school
22. Number of grades completed
23. Principal occupation
24. Secondary occupation

Form 2. Housing Characteristics

This form refers to the conditions of dwellings and the possession of household goods and was also used in the last census in the east. The variables included are aimed at qualitatively characterizing the housing. This form, as well as the first one, was also used with all families in the four communities. On this occasion

information on 1,962 dwellings was acquired. The variables included in the form are:

1. Village identification
2. Family identification
3. Type of housing
4. Possession of housing
5. Number of rooms in the dwelling
6. Material of the dwelling floor
7. Material of the dwelling ceiling
8. Material of the dwelling wall
9. Location of the kitchen in relation to the dwelling
10. Available cooking medium
11. Availability of electric light
12. Type of sanitary installation
13. Type of sewerage disposal
14. Type of water supply
15. Possession of household goods

Form 3. Economic Income

This form was utilized in interviewing all the families of the individuals born between 1962 and 1977, the base years for defining food supplementation in the original INCAP study. It includes the people currently living with the subjects who received supplements, either fruit drink or gruel, during childhood and who work or contribute some economic income to the family. In all, 822 surveys were collected. The information on family income includes information on which members of the family are producing it, for use in analysis of the individuals who received supplements.

The form covers a period of 10 months, from January to October 2000. It involves quantifying the monetary income from salaried employment (including wages, gratuities that may be received for work done, income from loans, Christmas bonuses, transportation, housing, or other goods), assistance from family and friends, alimony, gifts, and interest on savings, or loans. Also included are questions to quantify income from the sale of production, both agricultural and animal, and in-kind income, as in cases of personal consumption of family production. In order to estimate these in-kind entries that imply personal consumption, the same sale prices were applied as were used for the part of family production not consumed but sold.

Concretely, the variables included are:

1. Village identification
2. Family identification
3. Identification of informant
4. Date of the interview
5. Income from salaried work
    - 5.1 Types of occupations of all the subjects in the family
    - 5.2 Wages/income received from the occupation
    - 5.3 Extra hours
    - 5.4 Gratuities
    - 5.5 Fourteen-day certificates
    - 5.6 Christmas bonus
    - 5.7 In-kind income: housing, clothing, transportation, etc.
6. Other income
    - 6.1 Alimony
    - 6.2 Retirement pension
    - 6.3 Cash help from family members and friends
    - 6.4 Donations from institutions

6.5 Help from the church, the government, and foundations

6.6 Interest from saving

6.7 Loans

7. Income from animal husbandry

7.1 Quantity and types of animals raised

7.2 Quantity and types of animals sold

7.3 Quantity and types of animals raised and consumed in the home

7.4 Sale price of the animals

7.5 Losses in animal production

7.6 Quantity and types of products obtained from animals produced

7.7 Quantity and types of products obtained from animals sold

7.8 Quantity and types of products obtained from animals produced and consumed in the home

7.9 Sale price of the products obtained from animals

7.10 Losses from products obtained from animals

8. Income from crop production

8.1 Availability of land for cultivation on the property

8.2 Quantity and types of crops cultivated

8.3 Quantity and types of crops sold

8.4 Quantity and types of crops self-consumed

8.5 Sale price of the crops

8.6 Crop losses

8.7 Crops stored from previous harvests

(*) In boldface, the four variables incorporated into the forms during the review and clean-up of the data.

Form 4. Anthropometry

On this form, anthropometric information on the families of the individuals born during the years of supplementation (1962 to 1977) was recorded. Data were obtained from both the subjects who received supplements and all other members of their families, including spouses and children. In all, 164 forms were collected, with data on some 16 people on each of them. The variables included on this form are:

0. Identification of family member
1. Identification of individuals
2. Full name
3. Sex
4. Physiological status
5. Date of birth
6. Age (in years and months)
7. Date of measurement
8. Weight
9. Height

VI. STATISTICAL PROCESSING OF DATA

Stage Three began the second week of February in the Computation Center of INCAP, after the data collection was finalized. Several persons devoted themselves to the tasks of statistical processing, which was done in SAS format. For three weeks they worked on data entry, finishing the first week of March.

Subsequently, the review and selection of available data from 1969 to 1976 was started, along with the cleaning and checking of data from the year 2000. This activity revealed the existence of problems in various forms, making it necessary to rehire one of the interviewers to review all the forms, which led to delays in the process. During this review it was decided to add four new variables to the socioeconomic form with the object of quantifying information in the boxes for observations on the economic losses suffered by the families in the production of animals and products derived from them, agricultural products from the current harvest, and stocks from the previous harvest.

At the beginning of June data cleaning and the selection of a "master" list (participants in the 1962-1977 longitudinal study) from among all the individuals in the 2000 census were completed. Those activities were succeeded by the testing of hypotheses proposed in the original design and other tests suggested by new designs that were arising in the data analysis and interpretation phase.

In the case of the income variables, the available data were transformed logarithmically to normalize the highly asymmetrical distributions. To this end logarithms to the base 10 were used.

VII. DATA ANALYSIS

The analysis of the information was conducted from May to July. This phase was covered by a work team made up of staff members from INCAP and others from the United Nations system, as well as external economists hired for the development of the research.

A. Descriptive Characteristics of the Parents of the Study Subjects

Five variables describing the parents of the cases and controls were analyzed initially with the objective of validating the study hypotheses concerning similar family situations for cases and controls and determining possible biases in the data. These five variables, measured at different times between 1969 and 1977, are schooling, literacy, height, income, and participation of women in income generation. Also evaluated were the birthweights of the study subjects born within that period. The results are tabulated below.

Table A.1. Schooling of the parents of the study subjects, by type of supplement.

HYPOTHESIS	SEX	TREATMENT GROUP	DISTRIBUTION OF YEARS OF SCHOOLING	Chi-square (DF 2)	Pr>|t|	RESULT
Null→ Schooling (fruit drink) = Schooling (gruel) **Alternative→** Schooling (gruel) ≠ Schooling (fruit drink)	MOTHERS (n=698)	FRUIT DRINK (Control) (n=371)	59.84% none 32.61% between 1 and 3 7.55% more than 3	3.9409	0.1394	The mothers of the controls did not have different years of schooling than the mothers of the cases.
		GRUEL (Case) (n=327)	64.83% none 30.89% between 1 and 3 4.28% more than 3			
	FATHERS (n=571)	FRUIT DRINK (Control) (n=282)	53.19% none 31.56% between 1 and 3 15.15% more than 3	12.9551	0.0015	The fathers of the controls had more years of schooling than the fathers of the cases.
		GRUEL (Case) (n=289)	64.01% none 29.41% between 1 and 3 6.57% more than 3			

Table A.2. Literacy of the parents of the study subjects, by type of supplement.

HYPOTHESIS	SEX	TREATMENT GROUP	DISTRIBUTION OF LITERACY LEVEL	Chi-square (DF 2)	Pr>|t|	RESULT
Null→ Illiteracy (fruit drink) = Illiteracy (gruel) **Alternative→** Illiteracy (fruit drink) ≠Illiteracy (gruel)	MOTHERS (n=703)	FRUIT DRINK (Control) (n=373)	56.03% do not read 18.50% read a little 25.47% can read	4.2796	0.1177	There are no significant differences in degree of literacy between mothers of cases and mothers of controls.
		GRUEL (Case) (n=330)	62.12% do not read 18.79% read a little 19.09% can read			
	FATHERS (n=619)	FRUIT DRINK (Control) (n=307)	39.41% do not read 15.64% read a little 44.95% can read	11.9865	0.0025	The fathers of the controls have significantly higher degrees of literacy than the fathers of the cases.
		GRUEL (Case) (n=312)	52.88% do not read 14.10% read a little 33.01% can read			

Table A.3. Height of parents of the study subjects, by type of supplement.

HYPOTHESIS	SEX	AVERAGE HEIGHT (cm)	t-VALUE	Pr>|t|	RESULT
Null→ Parents' height (fruit drink) = Parents' height (gruel) **Alternative→** Parents' height (fruit drink) ≠ Parents' height (gruel)	MOTHERS (n=515)	Height (fruit drink) = 149.26 (n=254) Height (gruel) = 148.91 (n=261)	0.75	0.4524	There were no significant differences between the heights of the mothers of the cases and those of the mothers of the controls.
	FATHERS (n=325)	Height (fruit drink) = 161.18 (n=153) Height (gruel) = 159.93 (n=172)	1.94	0.0529	There is a great tendency for the heights of the fathers of the controls to be greater that those of the fathers of cases.

Table A.4. Annual earnings of the families of the study subjects during the supplementation program.

HYPOTHESIS	GROUP (n=730)	AVERAGE INCOME (quetzals)	t-VALUE	Pr>|t|	RESULT
Null→ Income (fruit drink) = Income (gruel) **Alternative→** Income (fruit drink) ≠ Income (gruel)	FAMILIES OF CASES (n=349)	Q292.56	-1	0.3177	There were no significant differences between the income levels of the parents of the children that received fruit drink and the income levels of those whose children received gruel in the longitudinal study in the communities.
	FAMILIES OF CONTROLS (n=381)	Q323.22			

Table A.5. Participation of the mothers of the study subjects in the generation of economic income.

HYPOTHESIS	GROUP (N=730)	ECONOMICALLY ACTIVE WOMEN (percent)	t- VALUE	Pr>|t|	RESULT
Null→ Participation of women (fruit drink) = Participation of women (gruel) **Alternative→** Participation of women (fruit drink) ≠ Participation of women (gruel)	MOTHERS OF CONTROLS (n=381)	2.89%	0.25	0.6141	There were no significant differences in the participation of the mothers of cases and those of controls in the generation of economic income.
	MOTHERS OF CASES (n=349)	2.29%			

Table A.6. Birthweight of the study subjects.

HYPOTHESIS	GROUP	AVERAGE BIRTHWEIGHT (kg)	t-VALUE	Pr>|t|	RESULT
Null→ Birthweight (fruit drink) = Birthweight (gruel) **Alternative→** Birthweight (fruit drink) ≠ Birthweight (gruel)	CASES (n=498)	3.08	-1.42	0.1552	Cases and controls did not have significant differences in birthweight.
	CONTROLS (n=476)	3.04			

B. Selected Characteristics of the Inhabitants of the Four Eastern Communities (Year 2000)

As a first approximation, on the basis of the general information from the 2000 census, analyses were conducted to determine the differences between communities receiving gruel and communities receiving fruit drink in terms of educational levels (grades completed in school and illiteracy), reproductive capacity of women (growth retardation in children at 36 months, number of deceased children), and possession of household goods in the home. The census included both adults that participated in the 1962-1977 longitudinal study and others.

Table B.1. Primary schooling of individuals included in the census.

HYPOTHESIS	SEX	TREATMENT GROUP n=3,019	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 2)	Pr>|t|	RESULT
Null→ Schooling (fruit drink) = Schooling (gruel) **Alternative→** Schooling (gruel) ≠ Schooling(fruit drink)	WOMEN (n=698)	FRUIT DRINK (Control) n=836	24.40% none 34.45% between 1 and 3 41.15% more than 3	11.6945	0.0029	The level of schooling of the adult women in the communities with the controls (receiving fruit drink) is higher than that in the communities with the cases (receiving gruel).
		GRUEL (Case) n=769	30.56% none 35.76% between 1 and 3 33.68% more than 3			
	MEN (n=571)	FRUIT DRINK (Control) n=723	20.47% none 25.03% between 1 and 3 54.50% more than 3	33.7458	<0.001	The level of schooling of the adult men in the communities with the controls (receiving fruit drink) is higher than that in the communities with the cases (receiving gruel).
		GRUEL (Case) n=691	27.64% none 33.29% between 1 and 3 39.07% more than 3			

Table B.2. Literacy of individuals counted in the census.

HYPOTHESIS	SEX	TREATMENT GROUP n=3,032	DISTRIBUTION OF LITERACY LEVEL	Chi-square (DF 2)	Pr>|t|	RESULT
Null→ Illiteracy (fruit drink) = Illiteracy (gruel) **Alternative→** Illiteracy (fruit drink) ≠ Illiteracy (gruel)	WOMEN	FRUIT DRINK (Control) n=837	24.13% do not read 12.78% read a little 63.08% can read	5.8720	0.0531	Significant differences between the levels of literacy of women in communities receiving fruit drink and those receiving gruel have not been demonstrated but there is a marked trend in favor of the former.
		GRUEL (Case) n=772	29.40% do not read 11.27% read a little 59.33% can read			
	MEN	FRUIT DRINK (Control) n=727	17.19% do not read 7.29% read a little 75.52% can read	11.9865	0.0025	The degree of literacy of men in the control communities is higher than that in the communities with the cases.
		GRUEL (Case) n=696	22.84% do not read 8.62% read a little 68.53% can read			

Table B.3. Growth retardation at 36 months of the children of individuals counted in the census.

HYPOTHESIS	AGE	Z SCORE (average)	N= 502	t-VALUE	Pr>|t|	RESULT
Null→ Z (fruit drink) = Z (gruel) **Alternative→** Z (fruit drink) ≠ Z (gruel)	36 MONTHS (measured between 1996 and 2000)	Z (fruit drink) = -1.663	n=275	-2.09	0.0367	The children of the women who live in the communities with the cases present less growth retardation at 36 months than the children of the women who live in the control communities.
		Z (gruel) = -1.471	n=227			

Table B.4. Prevalence of growth retardation at 36 months in children of individuals counted in the census.

HYPOTHESIS	AGE	TREATMENT GROUP	RETARDATION (percent of children with Z < -2 D.E.)	n = 502	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Percent delayed (fruit drink) = Percent delayed (gruel) **Alternative→** Percent delayed (fruit drink) ≠ Percent delayed (gruel)	36 MONTHS (measured between 1996 and 2000)	FRUIT DRINK (Control)	34.18%	n=275	0.0273	0.8687	The prevalence of growth retardation in the children at 36 months in the communities receiving gruel is the same as that in the communities receiving fruit drink.

		GRUEL (Case)	33.48%	n=227			

Table B.5. Number of deceased children in the families counted in the census.

HYPOTHESIS	TREATMENT GROUP n=1,817	DISTRIBUTION OF DECEASED CHILDREN < 60 MONTHS	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Num. of deceased children (fruit drink) = Num. of deceased children (gruel) **Alternative→** Num. of deceased children (fruit drink) ≠ Num. of deceased children (gruel)	FRUIT DRINK (Control) n=943	96.71% none 3.29% one or more	1.6903	0.1936	There were no significant differences between the communities with the cases and those with the controls, with respect to the number of deceased children per woman.
	GRUEL (Case) n=874	95.54% none 4.46% one or more			

Table B.6. Possession of goods in the families counted in the census.

HYPOTHESIS	GOODS	TREATMENT GROUP	PREVALENCE OF POSSESSION OF GOODS	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Prevalence of possession of goods (fruit drink) = Prevalence of possession of goods (gruel) **Alternative→** Prevalence of possession of goods (fruit drink) ≠ Prevalence of possession of goods (gruel)	TELEVISION	FRUIT DRINK (Control) n=880	64.20%	1.3556	0.2443	There are no demonstrated significant differences in the possession of television among the families of the communities receiving gruel and those receiving fruit drink.
		GRUEL (Case) n=786	66.92%			
	MOTORCYCLE	FRUIT DRINK (Control) n=880	1.36%	2.1756	0.1402	There are no demonstrated significant differences in the possession of motorcycles between the families of the communities receiving gruel and those receiving fruit drink.
		GRUEL (Case) n=786	0.64%			
	REFRIGERATOR	FRUIT DRINK (Control) n=880	24.66%	1.1840	0.2765	There are no demonstrated significant differences in the possession of refrigerators between the families of the communities receiving gruel and those receiving fruit drink.
		GRUEL (Case) n=786	22.39%			
	SOUND EQUIPMENT	FRUIT DRINK (Control) n=880	26.59%	0.8614	0.3533	There are no demonstrated significant differences in the possession of sound equipment between the families of the communities receiving gruel and those receiving fruit drink.
		GRUEL (Case) n=786	28.63%			

C. Selected Characteristics of the Study Subjects, by Period of Exposure to the Supplementation Program

Selected from among the individuals in the census were those who had participated in the longitudinal study between 1969 and 1977. All the individuals born in the communities with the cases and in those with the controls between 1962 and 1977 were listed in a database; these, then, were the children who were the object of the supplementation program. This group comprised the "MASTER" list.

Within that group, listed in another database were the individuals born in 1971 and 1973 and the year between. These individuals were exposed to the supplementation program during the entire gestation period and the first three years of life. The rest of the individuals were partially exposed in that crucial period for physical and mental development.

Analyses of fruit drink versus gruel were carried out for these two groups hoping to find stronger correlations in the group of individuals born between 1971 and 1973. Tests of hypotheses with regard to anthropometric variables (height), income (total individual income, percentage of women that generate income), and schooling (elementary grades completed) were conducted. The results are presented below:

Table C.1. Height of the study subjects, by treatment, sex, and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	SEX	AVERAGE HEIGHT (cm)		TUKEY GROUPING	RESULT
Null→ Height (fruit drink) = Height (gruel) **Alternative→** Height (gruel)≠ Height (fruit drink)	MASTER (1962-1977)	MEN n=1,235	Cases	163.7525	A	No differences in height were observed between cases and controls.
			Controls	163.0656	A	
		WOMEN n=1,158	Cases	150.4331	A	
			Controls	150.0108	A	
	SPECIAL MASTER (1971-1973)	MEN n=62	Cases	164.6000	A	No differences in height were observed between cases and controls.
			Controls	162.2487	A	
		WOMEN n=52	Cases	151.0153	A	
			Controls	149.0884	A	

Table C.2. Schooling of the study subjects, by treatment and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	TREATMENT GROUP	DISTRIBUTION OF YEARS OF SCHOOLING	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (fruit drink) = Schooling (gruel) **Alternative→** Schooling (gruel) ≠ Schooling (fruit drink)	MASTER (1962-1977)	FRUIT DRINK (Control) n= 749	34.31% with 0 to 4 65.69% with 5 or more	96.0773	<0.001	The schooling attained by the children exposed to the program is greater for the controls than for the cases.
		GRUEL (Case) n=784	59.31% with 0 to 4 40.69% with 5 or more			
	SPECIAL MASTER (1971-1973)	FRUIT DRINK (Control) n=163	30.67% with 0 to 4 69.33% with 5 or more	16.6509	<0.001	The schooling attained by the children exposed to the program for three years, starting with their gestation, is greater for the controls than for the cases.
		GRUEL (Case) n=177	52.54% with 0 to 4 47.46% with 5 or more			

Table C.3. Log_{10} of the income of the study subjects, by treatment and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	TREATMENT GROUP	AVERAGE INCOME (log_{10})	TUKEY GROUPING	R-square	RESULT
Null→ Income (fruit drink) = Income (gruel) **Alternative→** Income (gruel) ≠ Income (fruit drink)	MASTER (1962-1977)	FRUIT DRINK (Control) n= 565	3.07258	A	0.05628	The individual incomes of the controls are higher than those of the cases.
		GRUEL (Case) n=591	2.92138	B		
	SPECIAL MASTER (1971-1973)	FRUIT DRINK (Control) n=136	2.9750	A	0.127511	The individual incomes of the cases are equal to those of the controls.
		GRUEL (Case) n=125	2.9467	A		

Table C.4. Participation of the women in the study in income generation, by treatment and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	TREATMENT GROUP	ECONOMICALLY ACTIVE WOMEN (percent)	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Percentage of active women (fruit drink) = Percentage of active women (gruel) **Alternative→** Percentage of active women (gruel)≠ Percentage of active women (fruit drink)	MASTER (1962-1977)	FRUIT DRINK (Control) n= 240	46.67%	21.2797	<0.001	The participation of women in the generation of income is higher in the control group than in that of the cases.
		GRUEL (Case) n=220	25.91%			
	SPECIAL MASTER (1971-1973)	FRUIT DRINK (Control) n=64	46.88%	7.1584	0.0075	The participation of women in the generation of income is higher in the control group than in that of the cases.
		GRUEL (Case) n=59	23.73%			

D. Selected Characteristics of the Study Subjects, by Level of Caloric Intake of Supplement and Period of Exposure to the Supplementation Program

A new perspective was incorporated into the analysis with regard to the supplementation dosage for the mother (during the gestational period) and for the child (during the first 36 months of life) after it was discovered that there was an asymmetrical relationship between the doses ingested in each group, as summarized in the following table:

Study subjects (1962-1977)	**GRUEL (cases)**	**FRUIT DRINK (controls)**
HIGH CALORIC INTAKE (> median)	60%	39%
LOW CALORIC INTAKE (< median)	40%	61%
	100%	**100%**

Thus, the differences were analyzed among the master and special master groups in relation no longer to the treatment itself (fruit drink versus gruel), but to the level of intake of caloric supplement, of both the child and the mother. For the intake of children a cut-off point was established at the median intake level of each group (master and special master) that categorized the individuals as receiving high doses (higher than the median) and low doses (lower than the median). With regard to the mothers, the cut-off point was set at 20,000 calories. The cut off point for the "MASTER" group turned out to be 7,345.63 calories, and that of the "SPECIAL MASTER" group, 25,002.5 calories.

Individual total income and heights of men and of women were evaluated from this perspective.

Table D.1. Log_{10} of income of the study subjects, by level of intake and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	DOSAGE GROUP	AVERAGE INCOME (log_{10})	TUKEY GROUPING	R-square	RESULT
Null→ Income (high doses) = Income (low doses) **Alternative→** Income (high doses) ≠ Income (low doses)	MASTER (1962-1977)	HIGH DOSES n= 540	3.23152	A	0.052471	The group with high intake of supplement has significantly higher income than the group with low intake.
		LOW DOSES n=616	2.78819	B		
	SPECIAL MASTER (1971-1973)	HIGH DOSES n= 110	3.3479	A	0.116351	The group with high intake of supplement has significantly higher income than the group with low intake.
		LOW DOSES n=151	2.6799	B		

Table D.2. Height of the study subjects, by caloric intake of the mother and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	SEX	AVERAGE HEIGHT (cm)		TUKEY GROUPING	R-square	RESULT
Null→ Height (high doses) = Height (low doses) **Alternative→** Height (high doses) ≠ Height (low doses)	MASTER (1962-1977)	MEN n=287	High doses	164.0865	A	0.012483	There are no significant differences in height between the two groups.
			Low doses	162.2935	A		
		WOMEN n=375	High doses	149.4065	A	0.000833	
			Low doses	150.4461	A		
	SPECIAL MASTER (1971-1973)	MEN n=79	High doses	164.508	A	0.056458	There are no significant differences in height between the two groups.
			Low doses	161.443	A		
		WOMEN n=71	High doses	149.469	A	0.014593	
			Low doses	150.740	A		

Table D.3. Height of the study subjects, by caloric intake and period of exposure.

HYPOTHESIS	EXPOSURE GROUP	SEX	AVERAGE HEIGHT (cm)		TUKEY GROUPING	R-square	RESULT
Null→ Height (high doses) = Height (low doses) **Alternative→** Height (high doses) ≠ Height (low doses)	MASTER (1962-1977)	MEN n=282	High doses	164.1691	A	0.021145	The male cases are significantly taller than the male controls.
			Low doses	161.7860	B		
		WOMEN n=372	High doses	149.9484	A	0.056458	
			Low doses	151.1561	A		
	SPECIAL MASTER (1971-1973)	MEN n=79	High doses	164.476	A	0.045159	The male cases are significantly taller than the male controls.
			Low doses	160.900	B		
		WOMEN n=71	High doses	150.762	A	0.017478	
			Low doses	149.371	A		

G. Selected Characteristics of the Study Subjects, by Level of Caloric Intake of Supplement

A new research approach was tried when it was seen that the differences between the master and special master groups were basically in the magnitudes of the effects and not their direction. We focused on the supplementation dosage. An analysis of the distribution of individuals in the 1962-1977 study in terms of their total caloric intake of supplement revealed the following:

Individuals participating in the 1969-1977 study (n=2,202)	TOTAL CALORIC INTAKE OF SUPPLEMENT BY THE INDIVIDUALS IN THE PERIOD 1969-1977
Minimum	0
P_{25}	0
P_{50}	7,345.63
P_{75}	39,785.00
Maximum	406,792.50

A total of 550 cases (n < P_{25}) that presented caloric intake equal to zero in the first 36 months of life were available, which indicated that we could approximate a true control group. It was decided then to conduct the analysis taking for comparison the P_{25} and P_{75} groups of the intake of the individuals.

Table E.1. Height of the subjects with high intake (> 39,785 cal.) and zero intake, by sex.

HYPOTHESIS	SEX	AVERAGE HEIGHT (cm)		TUKEY GROUPING	R-square	RESULT
Null→ Height (high doses) = Height (low doses)	MEN n=179	High doses	164.7102	A	0.05216	The male cases are significantly taller than the male controls.
		Zero doses	160.9662	B		
Alternative→ Height (high doses) ≠ Height (low doses)	WOMEN n=223	High doses	149.4843	A	0.029487	
		Zero doses	151.7895	A		

Table E.2. Primary schooling of the subjects with high (> 39,785 cal) and zero intake.

HYPOTHESIS	DOSAGE GROUP	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high doses) = Schooling (low doses)	ZERO DOSES n=382	52.88% with 0 to 4 47.12% with 5 or more	0.2479	0.6185	There are no significant differences in primary schooling between cases and controls.
Alternative→ Schooling (high doses) ≠ Schooling (low doses)	HIGH DOSES n= 504	54.56% with 0 to 4 45.44% with 5 or more			

Table E.3. Secondary schooling of subjects with high (> 39,785 cal) and zero intake.

HYPOTHESIS	DOSAGE GROUP	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT

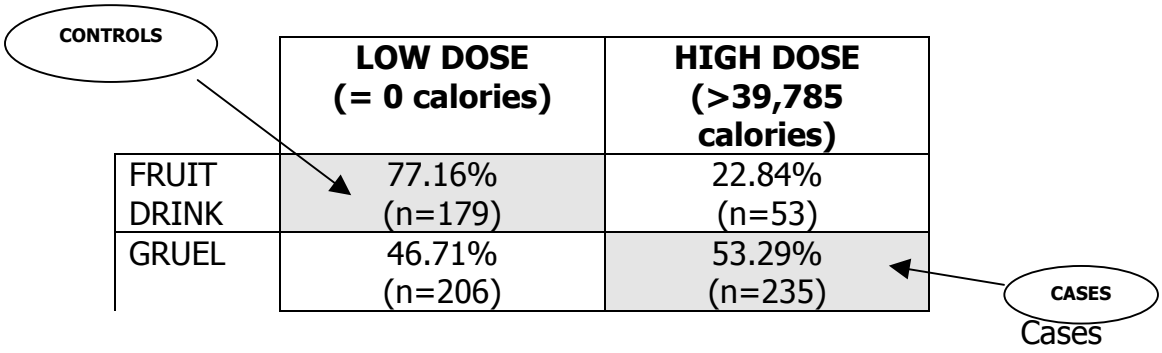
Null→ Schooling (high doses) = Schooling (low doses) **Alternative→** Schooling (high doses) ≠ Schooling (low doses)	ZERO DOSES n=381	86.09% with 0 13.91% with 1 or more	0.3653	0.5456	There are no significant differences in secondary schooling between cases and controls.
	HIGH DOSES n= 503	87.48% with 0 12.52% with 1 or more			

Table E.4. Log_{10} of income of the subjects with high intake (> 39,785 cal) and zero intake.

HYPOTHESIS	DOSAGE GROUP (N=675)	LSMEAN	F VALUE (DF 1)	Pr>|t|	RESULT
Null→ Income (high doses) = Income (low doses)	HIGH DOSES	3.38090	42.43	<0.001	Individual incomes for the cases are higher than those for the controls.
Alternative→ Income (high doses) ≠ Income (low doses)	ZERO DOSES	2.81247			

H. Selected Characteristics of the Study Subjects, by Type of Treatment and Level of Caloric Intake of Supplement

The relationship between the treatments (fruit drink versus gruel) and the two categories recently constructed in terms of the dosage was analyzed; "low dose" has zero calories/"high dose" has more than 39,875 calories. A very high correlation between the two categorizations was verified, as shown in the following table:



	LOW DOSE (= 0 calories)	HIGH DOSE (>39,785 calories)
FRUIT DRINK	77.16% (n=179)	22.84% (n=53)
GRUEL	46.71% (n=206)	53.29% (n=235)

In light of these results the issue of the treatment was taken up again. Thus, it was determined that the "case" group would be made up of the subjects who received supplements of gruel that they had ingested in high doses. The control group would be formed by the individuals in communities receiving the fruit drink that had not ingested a caloric supplement in the first 36 months of life. Discarded from the analysis were the

individuals in the communities that received the fruit drink whose intake was greater than zero and the individuals in the communities that received gruel whose intake was zero.

With this new study population, the values of the 25th and 75th percentiles, utilized as cut-off points in order to differentiate the subjects between "high intake of gruel" and "null intake" were zero for the 25th percentile and for the 75th percentile, 32,255 calories for the child and 13,870 for the mother.

Table F.1. Primary schooling of the subjects with high intake of gruel (> 32,255 cal) and the fruit drink subjects with zero intake.

HYPOTHESIS	DOSAGE GROUP	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (zero intake)	High gruel intake n=425	60.71% with 0 to 4 39.29% with 5 or more	19.9017	<0.001	The schooling of the controls is higher than that of the cases in the primary cycle.
Alternative→ Schooling (high intake ≠ Schooling (zero intake)	Zero intake n=191	41.36% with 0 to 4 58.64% with 5 or more			

Table F.2. Secondary schooling of the subjects with high gruel intake (> 32,255 cal) and the fruit drink subjects with zero intake.

HYPOTHESIS	DOSAGE GROUP	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (zero intake)	Gruel intake high n =425	89.18% with 0 10.82% with 1 or more	10.3781	0.0013	The schooling of the controls is higher than that of the cases in the primary cycle.
Alternative→ Schooling (high intake) ≠ Schooling (zero intake)	Zero intake n=190	79.47% with 0 20.53% with 1 or more			

Table F.3. Heights of the subjects with high gruel intake (> 32,255 cal) and the fruit drink subjects with zero intake.

HYPOTHESIS	SEX	DOSAGE GROUP	AVERAGE HEIGHT (cm)	F VALUE (DF 1)	Pr>F	RESULT
Null→ Height (high doses) = Height (low doses)	MEN n=125	High gruel intake	164.0931	6.24	0.0138	The height of the male cases is significantly higher than that of the male controls.
		Zero intake	159.4918			
Alternative→ Height (high doses) ≠ Height (low doses)						

	WOMEN n=158	High gruel intake	149.8510	0.08	0.7836	
		Zero intake	150.2650			

Table F.4. Height of the gruel subjects who are children of mothers with high intake (>13,875 cal) and the fruit drink subjects who are children of mothers with zero intake.

HYPOTHESIS	SEX	DOSAGE GROUP	AVERAGE HEIGHT (cm)	F VALUE (DF 1)	Pr>F	RESULT
Null→ Height (high doses) = Height (low doses) **Alternative→** Height (high doses) ≠ Height (low doses)	MEN n=120	High gruel intake	164.6375	3.37	0.0691	There is no difference, either in men or in women, in height in terms of the degree of supplementation of the mother.
		Zero intake	161.3796			
	WOMEN n=162	High gruel intake	151.4214	1.48	0.2251	
		Zero intake	150.3132			

Table F.5. Log_{10} of the income of the subjects with high gruel intake (> 32,255 cal) and the fruit drink subjects with zero intake, by income type.

HYPOTHESIS	INCOME CATEGORY	DOSAGE GROUP	LSMEAN	F VALUE (DF 1)	Pr>F	R-square	RESULT
Null→ Income (high doses) = Income (low doses) **Alternative→** Income (high doses) ≠ Income (low doses)	SALARY AND SELF-EMPLOYMENT INCOME n=416	High gruel intake n=179	1.925070	13.80	0.002	0.032266	The incomes of the cases are higher than those of the controls.
		Zero intake n=237	1.028876				
	DONATIONS AND AID n=416	High gruel intake n=179	0.524672	10.81	0.001	0.02547	The incomes of the controls are higher than those of the cases.
		Zero intake n=237	1.07191				
	FAMILY REMITTANCES n=416	High gruel intake n=179	-0.649583	3.01	0.00722	0.083	The incomes of the cases are higher than the incomes of the controls.
		Zero intake n=237	-0.835217				
	TOTAL INCOME n=416	High gruel intake n=179	3.273738	13.00	0.004	0.030437	The incomes of the cases are higher than the incomes of the controls.
		Zero intake n=237	2.919853				

A comparison of the distribution of the total nominal income of each of the two groups yields the following results:

INDIVIDUALS WITH INTAKE EQUAL TO ZERO			
INCOME TYPE	**MINIMUM INCOME**	**AVERAGE INCOME**	**MAXIMUM INCOME**
SALARY AND SELF-EMPLOYMENT INCOME **(1)**	Q0.10	Q4,744	Q75,000
DONATIONS AND AID **(2)**	Q0.10	Q403	Q11,500
FAMILY REMITTANCES **(3)**	Q0.10	Q158	Q18,000
TOTAL INCOME	**Q12.20**	**Q5,305**	**Q75,000**

INDIVIDUALS WITH HIGH GRUEL INTAKE			
INCOME TYPE	**MINIMUM INCOME**	**AVERAGE INCOME**	**MAXIMUM INCOME**
SALARY AND SELF-EMPLOYMENT INCOME	Q0.10	Q7,656	Q54,000
DONATIONS AND AID	Q0.10	Q369	Q13,600
FAMILY REMITTANCES	Q0.10	Q769	Q44,800
TOTAL INCOME	**Q0.30**	**Q8,794**	**Q58,000**

(1) Income from salaried work (including extra hours, gratuities, labor services, payments in kind) + Pension from retirement + Interest on saving + Agricultural and livestock production and animal products.

(2) Alimony + In-kind assistance + Donations from institutions, government, and churches + Loans.

(3) Family remittances.

G. Selected Characteristics of the Study Subjects, by Level of Caloric Intake of Gruel

In view of the fact that schooling is a variable highly related to social and community environment and to the possibilities of access, a final analysis was conducted utilizing only the individuals in the communities receiving gruel. With this, the intention was to isolate the possible bias from differences in structural conditions with regard to education in the different types of communities. Since a sufficient number of cases were available, the comparison was then established between individuals living in the

communities receiving gruel whose caloric intake of supplement in their first 36 months of life was zero and individuals in the same communities with high intakes in that same time period. Thus, we come closest to the definition of "control" for our study cases.

	INTAKE OF CHILDREN	
	LOW DOSE	**HIGH DOSE**
FRUIT DRINK	77.16% (n=179)	22.84% (n=53)
GRUEL	46.71% (n=206)	53.29% (n=235)
	n=385	n=288

CONTROLS *CASES*

	INTAKE OF MOTHERS	
	LOW DOSE	**HIGH DOSE**
FRUIT DRINK	68.95% (n=322)	31.05% (n=145)
GRUEL	70.75% (n=375)	29.25% (n=155)
	n=697	n=300

Table G.1. Primary schooling of subjects with high gruel intake (> 32,255 cal) and with zero gruel intake.

HYPOTHESIS	GRUEL INTAKE	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (zero intake)	High gruel intake n=425	60.71% with 0 to 4 39.29% with 5 or more	0.7613	0.3829	There are no differences in schooling between cases and controls.
Alternative→ Schooling (high intake) ≠ Schooling (zero intake)					

	Zero intake n=191	64.40% with 0 to 4 35.60% with 5 or more			

Table G.2. Secondary schooling of subjects with high gruel intake (> 32,255 cal) and with zero gruel intake.

HYPOTHESIS	GRUEL INTAKE	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (zero intake)	High gruel intake n=425	89.18% with 0 10.82% with 1 or more	1.8296	0.1762	There are no differences in schooling between cases and controls.
Alternative→ Schooling (high intake) ≠ Schooling (zero intake)	Zero intake n=191	92.67% with 0 7.33% with 1 or more			

Table G.3. Primary schooling of children of mothers with high gruel intake (> 13,870 cal) and children of mothers with zero gruel intake.

HYPOTHESIS	GRUEL INTAKE	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (zero intake)	High gruel intake n=293	56.66% with 0 to 4 43.34% with 5 or more	4.5736	0.0325	The cases have higher grades of schooling than the controls.
Alternative→ Schooling (high intake) ≠ Schooling (zero intake)	Zero intake n=364	64.84% with 0 to 4 35.16% with 5 or more			

Table G.4. Secondary schooling of children of mothers with high gruel intake (> 13,870 cal) and children of mothers with zero gruel intake.

HYPOTHESIS	GRUEL INTAKE	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (zero intake)	High gruel intake n=293	86.35% with 0 13.65% with 1 or more	3.8814	0.0488	The cases have higher grades of schooling than the controls.
Alternative→ Schooling (high intake) ≠ Schooling (zero intake)	Zero intake n=363	91.18% with 0 8.82% with 1 or more			

Table G.5. Height of subjects with high gruel intake (> 32,255 cal) and with zero gruel intake.

HYPOTHESIS	SEX	AVERAGE HEIGHT (cm)		F VALUE (DF 1)	Pr>F	RESULT
Null→ Height (high doses) = Height (low doses)	MEN n=125	High gruel intake n=88	164.0931	6.24	0.0138	There is a significant difference in the height of men that is not observed in women.
		Zero intake n=37	159.4918			
Alternative→ Height (high doses) ≠ Height (low doses)	WOMEN n=158	High gruel intake n=94	149.85	0.08	0.7836	
		Zero intake n=64	150.26			

Table G.6. Log_{10} of income of subjects with high gruel intake (> 32,255 cal) and with zero gruel intake, by type of income.

HYPOTHESIS	INCOME CATEGORY	GRUEL INTAKE	LSMEAN	F VALUE (DF 1)	Pr>F	R-square	RESULT
Null→ Income (high doses) = Income (low doses) **Alternative→** Income (high doses) ≠ Income (low doses)	SALARY AND SELF-EMPLOYMENT INCOME n=443	High gruel intake n=237	1.925070	52.18	<0.001	0.10579	The incomes of the cases are higher than the incomes of the controls.
		Zero intake n=206	0.316139				
	DONATIONS AND AID n=443	High gruel intake n=237	0.52467	40.07	<0.001	0.083295	The incomes of the controls are higher than those of the cases.
		Zero intake n=206	1.48529				
	FAMILY REMITTANCES n=443	High gruel intake n=237	-0.64958	2.11	0.00476	0.1467	The incomes of the cases are higher than those of the controls.
		Zero intake n=206	-0.80278				
	TOTAL INCOME n=443	High gruel intake n=237	3.273738	37.94	<0.001	0.79224	The incomes of the cases are higher than those of the controls.
		Zero intake n=206	2.705090				

A comparison of the distribution of the nominal total income of each of the two groups yields the following results:

INDIVIDUALS WITH INTAKE EQUAL TO ZERO (Gruel Communities)			
INCOME TYPE	**MINIMUM INCOME**	**AVERAGE INCOME**	**MAXIMUM INCOME**
SALARY AND SELF-EMPLOYMENT INCOME	Q0.10	Q3,614	Q50,400
DONATIONS AND AID	Q0.10	Q391	Q11,000
FAMILY REMITTANCES	Q0.10	Q327	Q37,500
TOTAL INCOME	**Q13.70**	**Q4,333**	**Q50,400**

INDIVIDUALS WITH HIGH INCOME (Gruel Communities)			
INCOME TYPE	**MINIMUM INCOME**	**AVERAGE INCOME**	**MAXIMUM INCOME**
SALARY AND SELF-EMPLOYMENT INCOME	Q0.10	Q7,656	Q54,000
DONATIONS AND AID	Q0.10	Q369	Q13,600
FAMILY REMITTANCES	Q0.10	Q769	Q44,800
TOTAL INCOME	**Q0.30**	**Q8,794**	**Q58,000**

Table G.7. Participation of women in the generation of income, by level of caloric intake in the communities receiving gruel.

HYPOTHESIS	GRUEL INTAKE	ECONOMICALLY ACTIVE WOMEN (percent)	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (low intake)	High gruel intake n=91	32.97%	0.0313	0.8596	No significant differences between the two groups are observed.
Alternative→ Schooling (high intake) ≠ Schooling (low intake)	Zero intake n=82	31.71%			

H. Analysis of Protein Intake in the Isocaloric Group in Communities Receiving Gruel

The effects of protein supplementation were then explored in the isocaloric group with high caloric intake in the community receiving gruel. Within that group with intake

higher than 32,255 calories, protein intake values between the 0 and 36 months fluctuated between 2,300 and 27,225 grams. Thus, two groups were created with reference to the median protein intake for the period (P_{50} = 7,033 g). These groups were compared in terms of height, schooling, and income. No significant differences between the two levels of protein intake were found in any of the analyses.

Table H.1. Primary schooling of the subjects with high gruel intake, by level of protein supplementation.

HYPOTHESIS	SEX	PROTEIN INTAKE	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (low intake) **Alternative→** Schooling (high intake) ≠ Schooling (low intake)	MEN n=221	High protein intake n=112	58.04% with 0 to 4 41.96% with 5 or more	0.3424	0.5584	There are no differences in schooling between cases and controls.
		Low protein intake n=109	54.13% with 0 to 4 45.87% with 5 or more			
	WOMEN n=204	High protein intake n=105	68.57% with 0 to 4 31.43% with 5 or more	0.7991	0.3714	There are no differences in schooling between cases and controls.
		Low protein intake n=99	62.63% with 0 to 4 37.37% with 5 or more			

Table H.2. Secondary schooling of subjects with high gruel intake, by level of protein supplementation.

HYPOTHESIS	SEX	PROTEIN INTAKE	DISTRIBUTION OF NO. OF GRADES COMPLETED	Chi-square (DF 1)	Pr>|t|	RESULT
Null→ Schooling (high intake) = Schooling (low intake) **Alternative→** Schooling (high intake) ≠ Schooling (low intake)	MEN n=221	High protein intake n=112	86.61% with 0 13.39% with 1 or more	0.1073	0.7432	There are no differences in schooling between cases and controls.
		Low protein intake n=109	88.07% with 0 to 4 11.93% with 5 or more			
	WOMEN n=204	High protein intake n=105	90.48% with 0 to 4 9.52% with 5 or more	0.1319	0.7165	There are no differences in schooling between cases and controls.
		Low protein intake n=99	91.92% with 0 to 4 8.08% with 5 or more			

Table H.3. Height of subjects with high gruel intake (> 32,255 cal), by level of protein supplementation.

HYPOTHESIS	SEX	PROTEIN INTAKE	AVERAGE HEIGHT (cm)	F VALUE (DF 1)	Pr>F	RESULT
Null→ Height (high doses) = Height (low doses) **Alternative→** Height (high doses) ≠ Height (low doses)	MEN n= 88	High protein intake	164.0088	0.01	0.9087	There were no differences were between protein supplementation groups.
		Low protein intake	164.1813			
	WOMEN n= 94	High protein intake	150.8040	0.74	0.3913	
		Low protein intake	148.8133			

Table H.4. Log_{10} of income of subjects with high gruel intake (> 32,255 cal) , by level of protein supplementation.

HYPOTHESIS	INCOME CATEGORY	PROTEIN INTAKE	LSMEAN	F VALUE (DF 1)	Pr>F	R-square	RESULT
Null→ Income (high doses) = Income (low doses) **Alternative→** Income (high doses) ≠ Income (low doses)	SALARY AND SELF-EMPLOYMENT INCOME n=237	High protein intake	1.920221	0.00	0.9757	0.0000	There are no differences observed in income by level of protein intake.
		Low protein intake	1.929960				
	DONATIONS AND AID n=237	High protein intake	0.55894	0.09	0.7585	0.0004	
		Low protein intake	0.49011				
	FAMILY REMITTANCES n=237	High protein intake	-0.59482	0.47	0.4952	0.0019	
		Low protein intake	-0.70480				
	TOTAL INCOME n=237	High protein intake	3.30626	0.23	<0.6295	0.0009	
		Low protein intake	3.24093				

VIII. RESULTS

A. Descriptive Characteristics of the Parents of the Study Subjects

CASES: FATHERS-MOTHERS OF GRUEL STUDY SUBJECTS

CONTROLS: FATHERS-MOTHERS OF FRUIT DRINK STUDY SUBJECTS

01. There was an initial bias in the study with regard to levels of schooling in favor of the communities receiving the fruit drink. This bias materialized in the higher educational level of the fathers of the children who were going to be the study controls (15% of them completed more than three grades in school in contrast to 6.5% in the communities receiving gruel, and 40% of them were illiterate in contrast to 53% among the fathers of the communities receiving gruel). This initial bias marked differences in the socioeconomic environment of the homes in favor of the children receiving fruit drink supplements, since a positive correlation between the schooling of fathers and children has been shown by previous studies, along with the importance of the schooling factor when effects on human capital based on nutritional interventions are investigated.

02. A strong trend became evident in the fathers of the children supplemented with fruit drink; they were found to be taller than the fathers of those receiving gruel supplements, which implied that the study had begun with a height bias that favored the controls over the cases.

03. There were no initial biases found with regard to the study subjects in terms of income levels in their homes, the participation of their mothers in the generation of income, or their height, schooling, or degree of literacy.

04. No differences in birthweight were found between those born between 1969 and 1977 who received gruel and those who received fruit drink.

B. Selected Characteristics of the Inhabitants of the Four Eastern Communities (2000)

CASES: INHABITANTS OF COMMUNITIES RECEIVING GRUEL (2000)
CONTROLS: INHABITANTS OF COMMUNITIES RECEIVING FRUIT DRINK (2000)

05. There are currently significant differences in schooling for both men and women between the communities receiving fruit drink and those receiving gruel. The gap found at the beginning of the 1970s in favor of the communities receiving fruit drink was wider in 2000; 54% of the adult men in those communities had three or more years of primary education in contrast to 40% in the communities receiving gruel. With regard to the women, these percentages are 41% in the communities receiving fruit drink and 34% in those receiving gruel. With regard to degree of literacy, the adult men in the communities receiving fruit drink (17% are illiterate) are also better off than their counterparts in the communities receiving gruel (23% are illiterate).

06. Differences are observed in growth retardation (measured at 36 months) in the current children in the communities. This difference is expressed as greater severity of malnutrition in children in the communities receiving fruit drink (average of -1.663Z) versus those receiving gruel (average of -1.471Z).

07. No significant differences were found between communities receiving fruit drink and those receiving gruel in the following variables: prevalence of growth retardation in children up to 36 months, the number of children dead at less than 60 months, and the possession of goods in the home (television, motorcycle, refrigerator, and sound equipment).

C. Selected Characteristics of Study Subjects, by Period of Exposure to the Supplementation Program

CASES: *STUDY SUBJECTS BORN BETWEEN 1962 AND 1977 AND BETWEEN 1971 AND 1973 RECEIVING GRUEL*

CONTROLS: *STUDY SUBJECTS BORN BETWEEN 1962 AND 1977 AND BETWEEN 1971 AND 1973 RECEIVING FRUIT DRINK*

08. The differences in schooling found at the community level were maintained, both for the study subjects born between 1962 and 1977 and those born between 1971 and 1973. For all study subjects, this difference finds expression in 66% of the adults of the communities receiving fruit drink having five years or more of schooling, in contrast to 41% of those in the communities receiving gruel. On disaggregating the data by sex, the differences in favor of fruit drink in both men and women were verified.

09. No differences in height, either in men (approximately 163 cm) or in women (approximagely 150 cm) were found, between communities receiving fruit drink and those receiving gruel for either of the two groups of subjects defined by year of birth.

10. In the subjects participating in the program who were born between 1962 and 1977, significant differences in income were detected, with the higher income obtained by the subjects in the communities receiving fruit drink. These differences were not detected in the group limited to those born between 1971 and 1973.

11. The participation of women in economic life appeared significantly greater in the communities receiving fruit drink (47%) than in those receiving gruel (26%). The results are similar when the analysis is restricted to the individuals born between 1971 and 1973.

D. Selected Characteristics of the Study Subjects, by Level of Caloric Intake of Supplement and Period of Exposure to the Supplementation Program

CASES: STUDY SUBJECTS BORN BETWEEN 1962 AND 1977 AND BETWEEN 1971 AND 1973//INTAKE 0-36 MONTHS > P_{50} (7,345 cal)
CONTROLS: STUDY SUBJECTS BORN BETWEEN 1962 AND 1977 AND BETWEEN 1971 AND 1073//INTAKE 0-36 MONTHS < P_{50} (7,345 cal)

12. Significant differences in income are observed between the individuals that consumed doses of supplement higher than 7,345 calories and those that consumed lower doses than that, regardless of the type of supplement they consumed. These differences, which imply higher income for those consuming more, are higher for the group born between 1971 and 1973 than for the entire group receiving supplements.

13. There are significant differences in the heights of the men; the height of the high consumers is greater than in that of the low consumers (164.16 cm in contrast to 161.78 cm, on the average). This difference, in men again, is greater for the group born between 1971 and 1973 (164.47 cm in contrast to 160.9 cm). The difference is observed neither in women nor in relation to supplementation of the mother during the gestation.

E. Selected Characteristics of the Study Subjects, by Level of Caloric Intake of Supplement

CASES: STUDY SUBJECTS //INTAKE 0-36 MONTHS > P_{75} (> 39,785 calories)
CONTROLS: STUDY SUBJECTS //INTAKE 0-36 MONTHS < P_{50} (> 0 calories)

14. There is a significant difference between the average height of individuals who consumed more than 39,785 calories of supplement in the first three years of life (164.71 cm) and that of those that did not consume supplement (160.96 cm). This difference is almost 4 cm in favor of the individuals who received supplement and is only demonstrated in men; the average height of the women is not significantly different for the two groups (approximately 150 cm).

15. Significant differences in schooling are not demonstrated between the high consumers and those who consumed no supplement (close to 46% of the subjects in both groups had completed five or more school grades).

16. Income (converted into logarithms to the base 10) was found to be higher for individuals whose intake was greater than 39,785 calories than for those whose intake was equal to zero in the first 36 months of life.

F. Selected Characteristics of the Study Subjects, by Type of Treatment and Level of Caloric Intake of Supplement

CASES: *STUDY SUBJECTS/TOTAL GRUEL INTAKE 36 MONTHS > 32,255 CALORIES*

CONTROLS: *STUDY SUBJECTS/TOTAL FRUIT DRINK INTAKE 36 MONTHS = 0 CALORIES*

17. There is a significant difference between the average height of men in the gruel community that consumed more than 32,255 calories of supplement in the first three years of life (164.71 cm) and that of the men in the community receiving fruit drink who did not consume supplement (160.96 cm). This difference is 3.8 cm in favor of the individuals receiving supplement and is only demonstrated in men; the average height of the women is not significantly different in the two groups (approximately 150 cm).

18. There were significant differences in schooling. The results were less favorable for the inhabitants of the communities receiving gruel and in favor of the adults in the communities receiving fruit drink who had zero intake in the first three years of life (59% of the controls had completed five or more years of primary school but only 40% of the cases had).

19. Total income was higher for individuals in the communities receiving gruel who had intakes higher than 32,225 calories between 0 and 36 months of life than for the individuals in the communities receiving fruit drink whose supplementary caloric intake was equal to zero. Comparison of the average total income of both groups yields a difference in monetary income (for a

period of 10 months) of Q3,489. The average for the group with zero intake is Q5,305, while for the high consumption group it is Q8,794. This difference represents, for the controls, an income that is 65% greater.

20. The range of income is higher for the group in the community receiving fruit drink whose intake is zero than for the group with high intake of gruel (Q0 to Q75,000 as compared to Q0 to Q58,000), which reveals a possible inequality in the capacity to generate income in the communities receiving fruit drink in comparison to the communities receiving gruel.

21. The group with high consumption generates higher income through salaried work, self-employment, and autonomous livestock production than the group with low consumption (an average of Q7,656 compared to Q4,744).

22. The group with low consumption generates higher income through aid and gifts from the government than the group with high consumption (Q403 compared to Q369). These items of income represent for the group with low consumption an average of 7.5% of their total income, versus 4.2% for the group with high consumption.

23. Significant differences could be seen between the two groups with regard to the income from remittances from family members that have migrated. These were greater for the cases (an average of Q769) than for the controls (an average of Q158). The family remittances comprise, on average, 9% of the income of the individuals with high intake and only 3% for those with zero intake. The maximum value of the remittances received in the group of high intake (Q44,800) is two and a half times greater than the maximum value received in the group with zero intake (Q18,000).

G. Selected Characteristics of the Study Subjects, by Level of Caloric Intake of Gruel

CASES: GRUEL STUDY SUBJECTS /INTAKE 0-36 MONTHS > P_{75} (> 32,255 cal)

CONTROLS: GRUEL STUDY SUBJECTS /INTAKE 0-36 MONTHS = 0 calories

24. No significant differences in schooling were evident in the community receiving gruel between subjects with high doses of caloric supplement in first 36 months of life and the subjects with zero intake of supplement in that same period. At the primary level, the percentage of adults who have completed five or more grades of school is, on the average, between 36% and 40%, while at the secondary level, it is between 7% and 10%, with the higher percentages for the high intake groups. An analysis by sex did not yield dissimilar results.

25. Significant differences could indeed be seen in schooling when the different categories of supplementation of the mother were analyzed. Thus, for both primary and secondary, the adults whose mothers ingested more than 13,870 calories in supplement during pregnancy showed more success than the adults whose mothers had a supplemental caloric intake equal to zero in that same period (43% compared to 35% with five or more elementary grades completed and 14% compared with 9% with one or more secondary grades completed).

26. A significant difference was observed in the height of men, which could not be demonstrated for women. This difference was, on average, 4.6 cm in

favor of the men with high caloric intake in the communities receiving gruel, compared to those with low intake.

27. With regard to income, this new analysis corroborated the previous results, expanding the differences between the two groups. The current control group, consisting of subjects from the community receiving gruel whose intake was zero, shows lower income than the controls of the previous analysis, who were subjects from the community receiving fruit drink whose intake was zero, that is, Q4,333 on the average, in contrast to Q8,794 for the cases. That difference implies that the cases receive twice as much income as the controls.

28. The other trends observed with regard to income from gifts and family remittances remained. Thus, the cases obtained, on the average, an income through salaried work, gifts, and remittances of Q7,656, Q369, and Q769, while for the controls the figures were Q3,614, Q391, and Q327.

29. The range of income is slightly higher for the high intake group (Q0 to Q58,000 compared to a range of Q0 to Q50,000 for the group with zero intake), which suggests possible greater equity in the capacity to generate income within the communities receiving gruel.

30. There were no demonstrated differences in the degree of participation of women in the generation of economic income in the home, which was at a level close to 32% for both groups.

H. Analysis of Protein Intake in an Isocaloric Group in Communities Receiving Gruel

CASES: GRUEL STUDY SUBJECTS /INTAKE 0-36 MONTHS > 32,255 cal and >7,033 g protein

CONTROLS: GRUEL STUDY SUBJECTS /INTAKE 0-36 MONTHS > 32,255 cal and < 7,033 g protein

31. No differences were noted in height, in primary and secondary schooling, or in income when protein intake levels were compared during the first 36 months of life for the isocaloric group with high gruel intake.

PRINCIPAL FINDINGS

Table II. **Individual income (from January to October 2000) of subjects of the Eastern Longitudinal Study from the communities receiving gruel, by level of caloric supplementation from 0 to 36 months of age.** ***ABSOLUTE VALUES (nominal quetzals).***

	Intake higher than 32,000 calories (a)	Intake equal to zero calories (b)	(b/a)
Total income	**Q8,794**	**Q4,333**	**49%**
Income from salaried work and self-employment	Q7,656	Q3,614	47%
DONATIONS AND AID	Q369	Q391	105%
Family remittances	Q769	Q327	42%
Average monthly income	**Q879**	**Q433**	**49%**

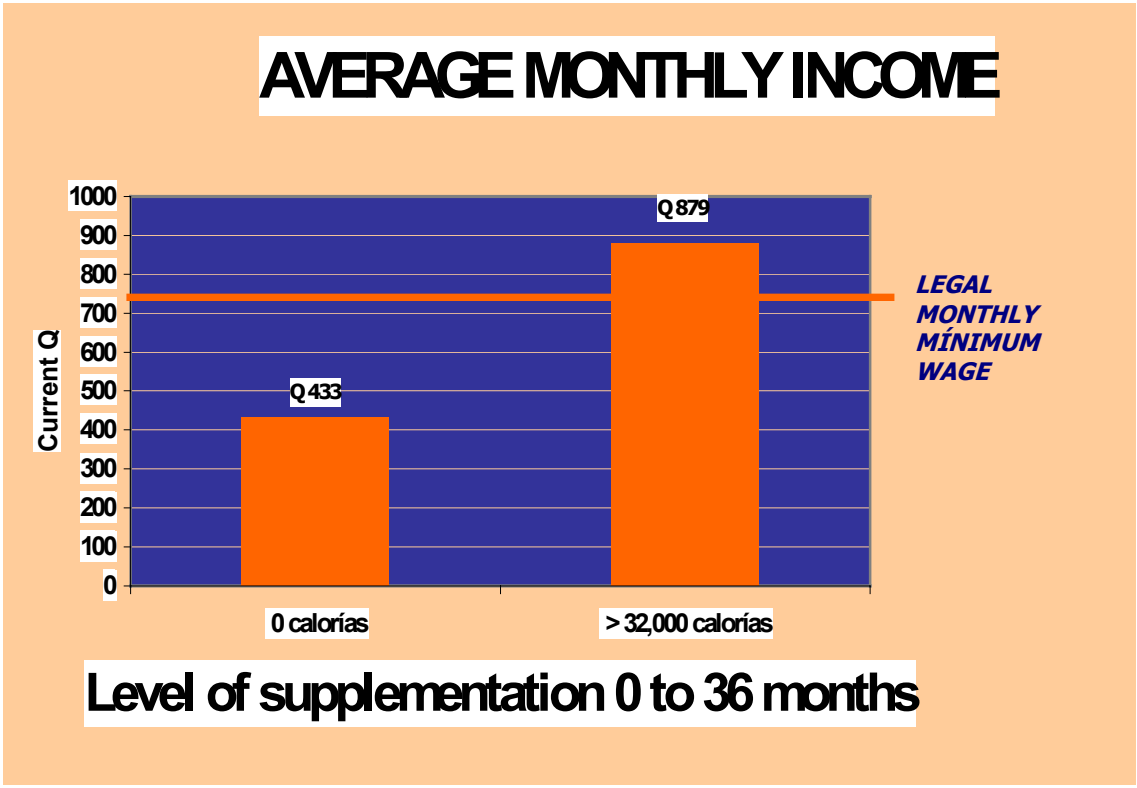
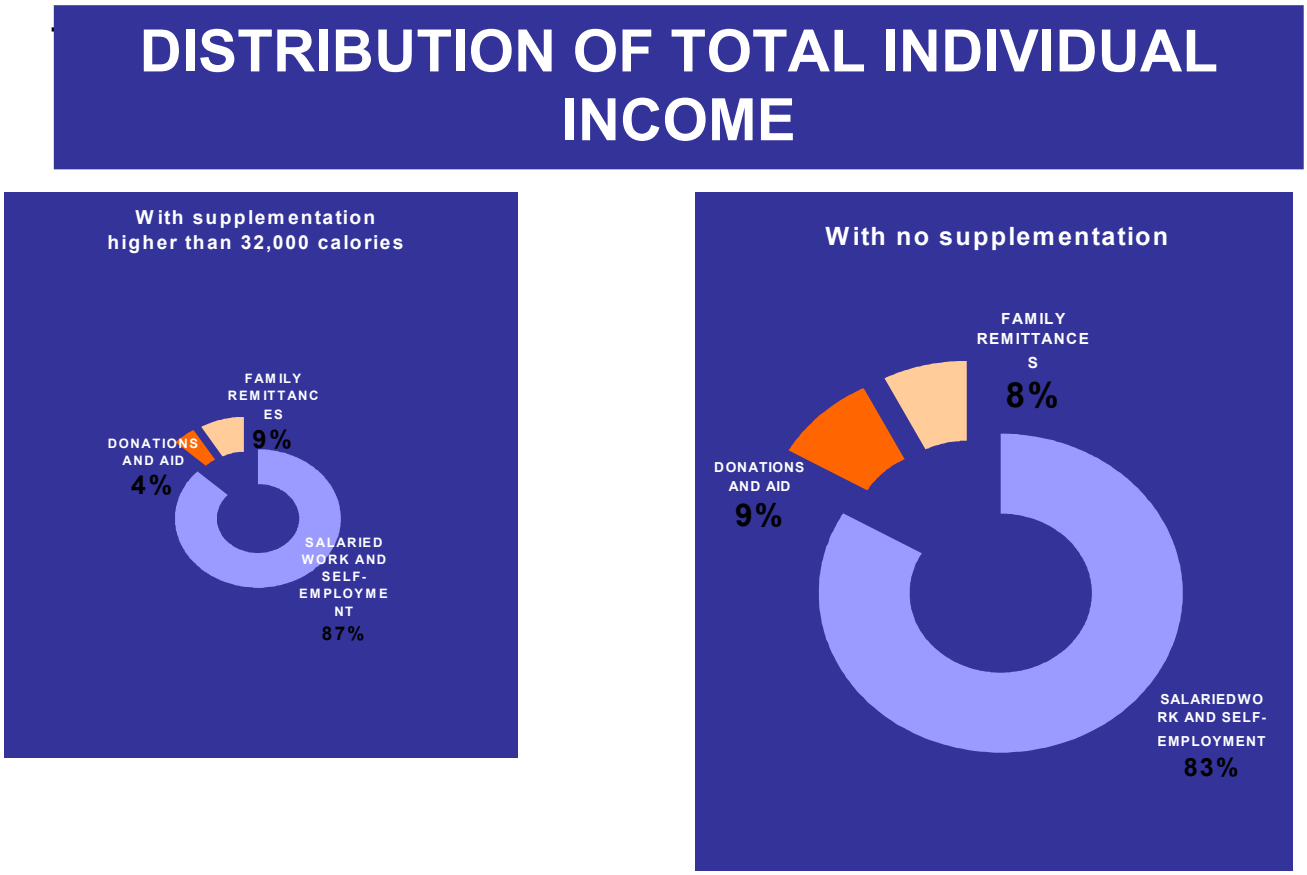
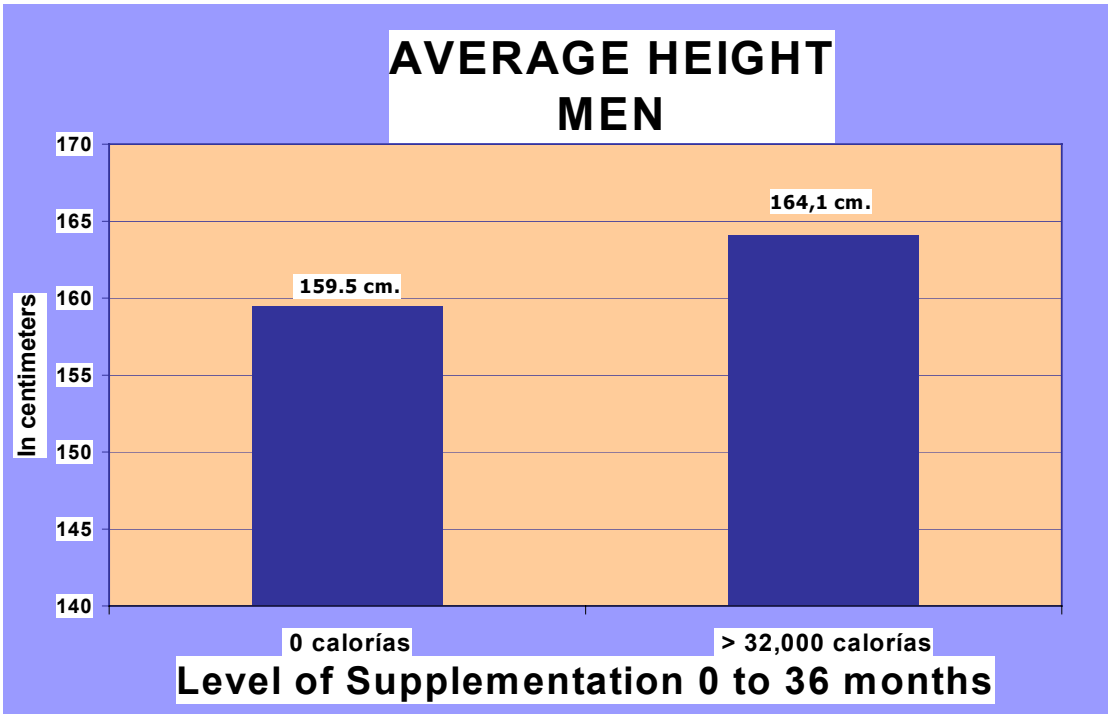


Table III. **Individual income (from January to 2000) of subjects of the Eastern Longitudinal Study from communities receiving gruel, by level of caloric supplementation from 0 to 36 months of age. *RELATIVE VALUES (percent)***

	Intake higher than 32,000 calories (a)	Intake equal to zero calories (b)
Total income	**100%**	**100%**
Income from salaried work and self-employment	87%	83%
DONATIONS AND AID	4%	8%
Family remittances	9%	9%





X. CONCLUSIONS

01. The positive fruit drink bias for schooling in adults found in the communities at the beginning of the study has continued in the same direction up to the present time for the study subjects who are adults today, but is increasing in intensity. Using results from previous studies in which a strong correlation between schooling and levels of income is demonstrated, one can state that this bias points toward the lack of validity of considering the communities receiving fruit drink and the individuals receiving supplements there as the control group for our study. Indeed, the comparisons between communities receiving fruit drink and those receiving gruel show better results for schooling, income, and participation of women in the generation of income in the former than in the latter. The subjects of study within each community do not avoid the community patterns, also showing better results for those three variables from fruit drink groups than gruel groups. It is for this reason that the **gruel/fruit drink dimension** does not seem to be the fundamental research question, given the initial socioeconomic conditions of the communities under study, to evaluate the true effect of early nutritional supplementation on the formation of human capital.

02. The **temporal dimension** of the analysis, differentiating the individuals that were exposed to the nutritional and health intervention throughout their gestation and first 36 months of life from those who were only partially exposed, is indeed a relevant question in research on the effects of supplementation. Although, in general, the analyses of cases and controls in both groups yield results for the different variables in the same direction, they generally show relevant differences of magnitude. These differences are translated into wider gaps between cases and controls in terms of income, schooling, participation of women, and height in favor of the individuals exposed to supplementation during the entire first 36 months of life.

03. The **supplementation dosage** turns out to be the key research question and it is based on this criterion that it is possible to arrive at a version that more closely approximates a control group. This occurs mainly because among both the fruit drink and the gruel groups the intake of a significant percentage of subjects is equal to zero during the first 36 months of life, which distorts the fruit drink/gruel analyses for the different variables.

04. The individuals with high caloric intakes of supplement in the first 36 months of life presented significant differences in income and height (this latter only in men) than those that did not ingest supplement. Within the community receiving gruel, these differences were Q4,400 and 4.6 cm in height for men. With respect to income, that of the high intake group was double that of low intake group. Preliminarily, the positive correlation between nutritional supplementation in infancy and height and the generation of income in adult life stands proven.

05. Correlation between levels of intake and levels of schooling could not be proven. This was probably related to the indicators utilized for schooling, which have more to do with community socioeconomic conditions than with individual aptitudes.

06. A correlation is noted between low intake of supplement and higher income from gifts from governmental and nongovernmental institutions and churches, which suggests the idea of greater vulnerability in that group, which makes it the object of institutional social welfare programs.

07. A correlation is observed between high intakes of supplement and the highest income under the heading of family remittances from governmental and nongovernmental institutions and churches, which suggests that migration in those communities is related to greater personal capacity for seeking better opportunities.

08. Inequity in the communities receiving fruit drink points to possibly greater inequity with regard to the capacity of individuals to generate income in comparison with those receiving gruel, since they present a broader range of the income generated.

09. All the groups manifested a possible situation of inequity for women in the home which, it seems, is being imposed in contradiction to the supplementation programs in infancy.

XII. RECOMMENDATIONS

01. The subjects in the communities receiving gruel and fruit drink are not comparable in terms of schooling and income, given the initial bias in existing schooling in favor of the fruit drink group at the beginning of the study. Cases and controls should be formed separately for the communities receiving gruel and fruit drink and, between communities, to compare only the relative improvements of cases over controls in the expectation that these relative differences are greater in the communities receiving gruel, through the effect of the additional protein supplement. The rest of analysis should focus on the intracommunity area.

02. Define with precision the group of cases and controls in the Eastern Longitudinal Study in order to delve more deeply in future research into the preliminary results noted in the present study. With respect to certain criteria, form smaller groups that will make tests, surveys, and detailed analyses of each individual feasible. These criteria should consider the temporal perspective, supplementation dosage, and the sex dimension, since they have shown to be pertinent research issues. Furthermore, since the ingested dose is the fundamental issue, one piece of data to incorporate is the intake of the subjects in the home during the first 36 months of life, information that was collected during the longitudinal study based on 24-hour histories recorded periodically.

03. Improve the indicators to measure schooling. Those utilized in the present research, years of schooling and grades completed, used separately as in this case, are more a reflection of the socioeconomic structural conditions in the environment than of the intellectual capacity of the individuals. A combination of the two indicators could reflect that capacity more faithfully, along with the

inclusion of tests of knowledge in order to evaluate logical-mathematical, psychoemotional, and linguistic skills, for example.

04. Improve income measurement, incorporating an analysis of spending that corroborates and/or approximates real income levels more faithfully. Given that income data are available for each individual, it would be significant to carry out analyses by sex in order to avoid biases against women. Other matters concerning how to compare individual, family, and per capita income should be studied before considering the positive relationship between intake and income generation convincingly demonstrated.

05. Monitor the individuals who have migrated and analyze their income levels in order to corroborate the initial thesis that migrants are those who have developed greater personal capacities thanks to supplementation.

06. Delve further into research on income from DONATIONS AND AID from institutions in order to corroborate the initial thesis that those who acquired lower personal capacities by not benefiting from supplementation are today the object of social welfare programs.

07. Delve further into the analysis of existing inequities in both communities, considering the ranges of income and the Gini coefficient, both at the starting point and at the time of the research, since the preliminary results here point to greater inequity in the communities receiving fruit drink.

08. Conduct an analysis to answer the question of why no differences in height are seen in women, which could be related to similar inequities suffered by women in all the groups.

09. Conduct detailed socioeconomic analyses in the communities to determine the personally experienced transformations from various points of view, including political, economic, social, religious, and demographic, since the beginning of the longitudinal study.

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(Research based on the EASTERN LONGITUDINAL STUDY)

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Final Consultants' Report

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Institute of Nutrition of Central America and Panama

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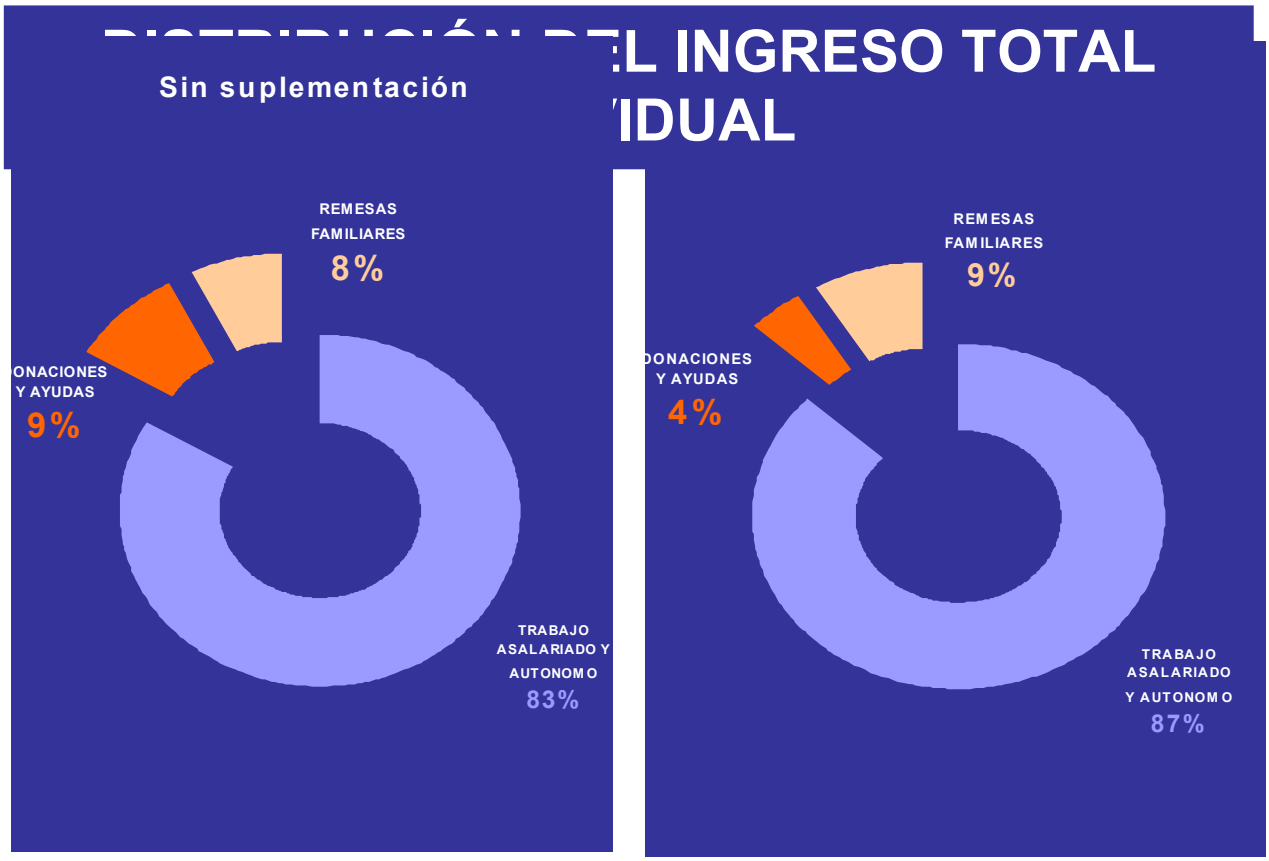

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H. Analysis of Protein Intake in the Isocaloric Group in Communities Receiving Gruel

I. INTRODUCTION

The impact of adequate early nutrition on height, muscle mass, and psychoeducational abilities in adolescent life has already been demonstrated[9,10,11,12] -- findings suggesting that, for societies that make heavy use of manual labor, this impact should be far-reaching and extend into adult life in the form of higher income.

This report presents the results of the cross-sectional study conducted in the second half of 2000, whose objective was to validate that hypothesis and determine the effects of early nutritional supplementation on income levels and well-being in adults, based on the data from the Eastern Longitudinal Study from 1969 to 1977 conducted by the Institute of Nutrition of Central America and Panama (INCAP). The report presents information on the research process in its different stages as well as the results obtained.

To carry out the work, four stages of research were conceived: design, data collection, processing and statistical analysis of the data, and analysis of results. The products of each of them are presented below.

In the final sections of the document, the actual findings as well as recommendations and orientations for future processing of data from the 2000 census and the longitudinal study are summarized.

[9] Galler JR, Ramsey F, Solimano G, Lowell WE. The influence of early malnutrition on subsequent behavioral development. II. Classroom behavior. J Am Acad Child Psychiatry 22: 16-22, 1983

[10] Pollit E, Gorman KS, Engle P, Martorell R and Rivera JA. Early Supplementary Feeding and Cognition Effects Over Two Decades. Monographs of Society for Research in Child Development 1993, Serial No. 235,58 (7): 122 pages.

[11] Behrman JR, Foster A, Rosenzweig MR. The dynamics of agricultural production and the calorie-income relationship: Evidence from Pakistan. J Econometrics 77 (1): 187-207.

[12] Deolalikar AB. Nutrition and labor productivity in agriculture: Estimates for rural South India. RvwEcon Stats 70(3): 406-13,1988

II. BACKGROUND

In 1969 INCAP initiated the Eastern Longitudinal Study in four rural communities in eastern Guatemala. The individuals included in this study—a total of 2,393 in all--participated in a program of protein-energy supplementation (the cases) and energy supplementation (the controls); both groups also received health care. The cases, who received supplements of gruel between 1969 and 1977, were all the children born between 1962 and 1977 in the communities of Conacaste and San Juan, both belonging to the Municipio of Sanarate in the Department of El Progreso. The controls, in turn, who received supplements in the form of a fruit drink between 1969 and 1977, were all the children born between 1962 and 1977 in the communities of Santo Domingo, Municipio of San Antonio La Paz, and Espíritu Santo, Municipio of El Jícaro, both in the Department of El Progreso. The dosages of the supplements received by each study subject, which were offered ad libitum, were controlled during every year of the intervention, which permits us today to categorize the individuals as higher and lower consumers. A more detailed description of this study can be found in the *Journal of Nutrition* (Volume 125, April 1995) and in *Food and Nutrition Bulletin* (Volume 14, September 1992).

Over the years, several cross-sectional studies[13,14,15] have been carried out with the intention of measuring the effects of nutritional supplementation on the anthropometric and health status of these individuals. Some indications of effects on other variables of social development, such as schooling or income, have motivated INCAP to implement this new initiative in an effort to clarify with scientific rigor the causality between the nutritional and health interventions undertaken in the past and

[13] Martorell R. Results and implications of the INCAP follow up studies. J Nutr 125 (4S): 1127S-1138S, 1995.
[14] Rivera JA, Martorell R, Ruel MT, Habitcht J-P and Haas J. Nutritional supplementation during prescholl years influences body size and composition of Guatemalan adolescents. J Nutr 125 (4S): 1068S-1077S, 1995
[15] Khan A. Schroeder DG, Martorell R and River JA. Age at menarche and nutritional supplementation. J Nutr 125 (4S): 1090S-1096S, 1995.

factors of human development, such as the current socioeconomic conditions of these individuals.

III. OBJECTIVES

4. Evaluate the effect of early supplementation on the height of the adult.

5. Evaluate the effect of early supplementation on human capital formation, measured using education, health, and reproductive capacity as variables.

6. Evaluate the effect of early supplementation on the current level of well-being and income of the adults.

IV. STUDY METHODS

1. Design of the Study

This phase of the work was conducted in August and September 2000 and involved personnel specializing in economics and food and nutrition security. The available literature on the Eastern Longitudinal Study was reviewed at the beginning of the 1970s along with the successive cross-sectional studies conducted subsequently as follow-up to the first one.

This review made it possible to identify the information from previous studies that could be utilized as a baseline for current research. The guidelines for the data collection in the year 2000 were developed on that basis. Thus, it was determined that a possible correlation would be sought among:

d) the nutrition and health intervention in children (which occurred between 1969 and 1977).
e) the improvement in human capital in adults (measured using education, health, and reproductive capacity of these people in the year 2000 as variables).
f) the increase in income and well-being in adults in the year 2000.

Given the 25 years that separated the research periods and through a study of cases (children who received supplements of gruel) and controls (children who received a supplement in the form of a fruit drink), it was decided that all comparisons of data done in a search for possible positive effects of supplementation on human capital, income, and well-being would be based on differentials between cases and controls at a single moment in time.

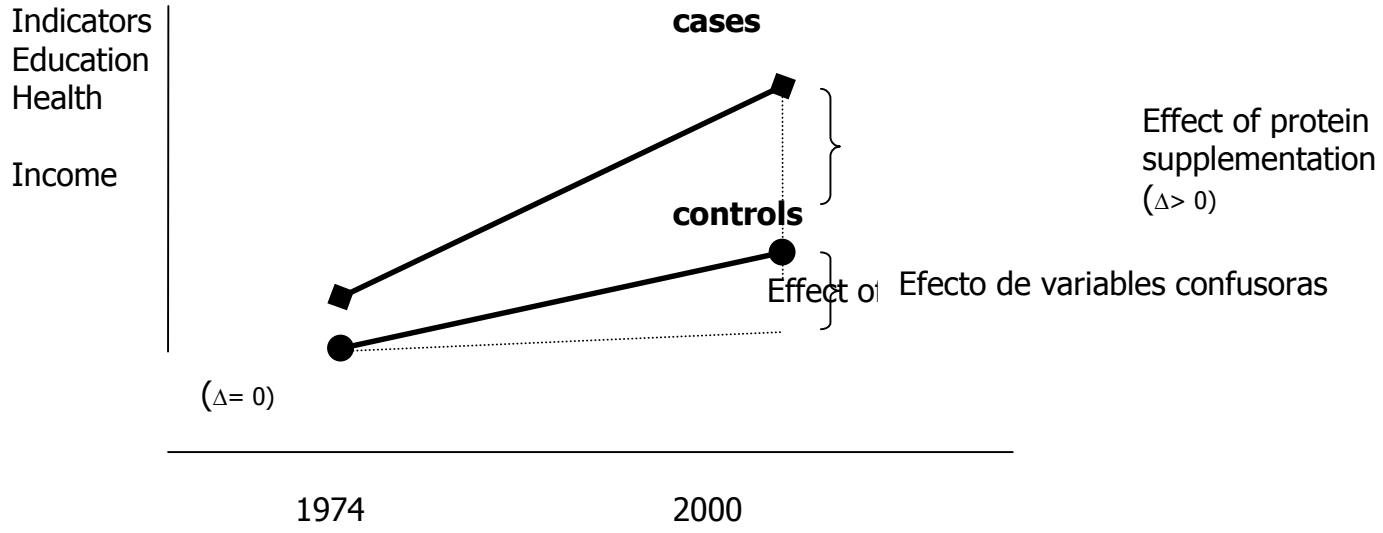
That is, an analysis was designed on the basis of comparisons of the differentials between cases and controls in 1974 and between cases and controls in the year 2000. In this way data from 1974 and the year 2000 were never compared directly. This was done it way since the variables utilized in the study to measure the long-term impact of the nutritional and health intervention on children are development variables that are subject to the influence of a multitude of external factors that have to do with educational, health, and macroeconomic policies in Guatemala in the last 25 years as well as other factors, such as trends in migration. A comparison of educational indicators in absolute terms--for example, between 1974 and 2000--would not have sufficient scientific validity to demonstrate the positive impact of the intervention, since an improvement in human development conditions could be expected in both cases and controls, regardless of the effect of the dietary supplements. Comparison of differentials does have the power to demonstrate the effects of the intervention, inasmuch as confounding variables[16] that would affect cases and controls in a similar manner may possibly be incorporated in the design.

Thus, the study is a comparative analysis of two moments in the lives of the subjects, one in 1974 and the other in 2000. Both moments are framed within given socioeconomic conditions, and it is the comparison of cases and controls at one time that makes it possible to eliminate the influence of these confounding variables on measurements of the impact of supplementation.

The general hypothesis of the study is that, starting from a similar situation in 1974, an improvement can be seen in the variables of development in the year 2000 versus 1974. There has been a general improvement for all the families because of the advances in development in Guatemala, but it is greater in the families of the cases than in those

[16] Confounding variables are understood to be those that, although not the object of the study, determine and affect the study variables. In this study, control of the confounding variables is accomplished by considering them in the design phase.

of the controls. Dosages received and supplementation periods are also considered variables in the comparison of cases and controls.



This approach was applied to the design of research on human capital (education and health) and on income and well-being. It could not be utilized to measure an impact on mortality in view of the fact that the deaths of children in 1974 eliminate the possibility that they could be parents of children whose mortality would be measured in the year 2000. It is for this reason that that analysis will be based only on the search for differences between cases and controls in those years.

For the measurement of **improvement in human capital** (Point b), the following were measured:

3. Education

3.1 Measurement of the effect of supplementation on the school grade achieved by the children, based on the comparison of the schooling differential between the parents of the children who received supplements (1974) and the schooling differential for the children who received supplements (2000).

Research hypothesis: There are significant positive differences in school grade achieved between cases and controls in the year 2000 (the null hypothesis H_o for that year is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o for that year is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

3.2 Measurement of the effect of supplementation on the degree of literacy attained by the children based on comparison of the differential for literacy among the parents of the children who received supplements (1974) and the differential for schooling among those children who received supplements (2000).

Research hypothesis: There are significant positive differences in the degree of literacy between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

2. Health

2.3 Measurement of the effect of supplementation on height based on the comparison of the height differential among the parents of the children who received supplements (1974) and the height differential among the children who received supplements (2000).

Research hypothesis: There are positive significant differences in height between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

2.4 Measurement of the effect of supplementation on mortality using the mortality differential between the two groups supplemented in their infancy.

Research hypothesis: There are significant negative differences in mortality between cases and controls in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta < 0$

4. Reproductive capacity

4.1 Measurement of the effect of supplementation of the current mothers on the birthweights of their children from the birthweight differential between the children of the two groups supplemented in their infancy (cases and controls).

Research hypothesis: There are positive significant differences between cases and controls in birthweights of the children in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta > 0$

4.2 Measurement of the effect of supplementation of the current mothers on growth retardation in their children (at 12, 24, and 36 months), based on the differential in growth retardation among the children of the two groups supplemented in their infancy (cases and controls).

Research hypothesis: There are significant negative differences in growth retardation between cases and controls in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta < 0$

(** These data were collected from 1996 to 2000.)

4.3 Measurement of the effect of supplementation of current mothers on the mortality of their children, based on the mortality differential among the children of the two groups supplemented in their infancy (cases and controls).

Research hypothesis: There are significant negative differences in child mortality between cases and controls in the year 2000 (the null hypothesis H_o is rejected).

2000: $H_o : \Delta = 0$

$H_a : \Delta < 0$

For measurement of the effects on **income and well-being** (Point c), the following were defined:

3. Income

3.1 Measurement of the effect of supplementation on the capacity to generate income, based on comparison of the income differential among the parents of the children who received supplements (1974) and the income differential among the children that received supplements (2000). The income is calculated as the sum of income from salaried work, sale and personal consumption of production, gratuities, gifts, pensions, and remittances.

Research hypothesis: There are significant positive differences in capacity to generate income between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their parents in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ $\quad$ $H_a : \Delta \neq 0$

2000: $H_o : \Delta = 0$ $\quad$ $H_a : \Delta > 0$

3.2 Measurement of the effect of supplementation on the participation of women in the generation of family income, based on comparison of the differential in the percentage of economically active women among the mothers of the children who received supplements (1974) and the differential in the percentage of economically active women among the girls who received supplements (2000).

Research hypothesis: There are significant positive differences in degree of participation of women in economic life between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that

were not detected in their mothers in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

4. Well-being

4.1 Measurement of the effect of supplementation on family well-being, based on comparison of the differential in housing quality among the parents of the children who received supplements (1974) and the differential in housing quality among the children who received supplements (2000). The measure of well-being is based on the possession of housing and the building materials used.

Research hypothesis: There are significant positive differences in degree of participation of women in economic life between cases and controls in the year 2000 (the null hypothesis H_o is rejected) that were not detected in their mothers in 1974 (the null hypothesis H_o is not rejected).

1974: $H_o : \Delta = 0$ 2000: $H_o : \Delta = 0$

$H_a : \Delta \neq 0$ $H_a : \Delta > 0$

4. Study Population

The study population comprises the individuals born between 1962 and 1977 and living in Conacaste, San Juan, Santo Domingo, and Espíritu Santo, communities in eastern Guatemala, in the year 2000. These selection criteria group the people who were exposed to the INCAP supplementation program, conducted between 1969 and 1977, a total of 2,393 individuals.

3. Sample Size

Information was gathered using four forms, two of them designed for the general population residing in the communities in the study and the other two for the specific group of individuals that participated in the longitudinal study from 1962 to 1977 and their current families. In the following table, information on the size of the sample obtained from each of them is summarized, at both the family and individual levels. The data presented correspond to the sample sizes that could be utilized in the data analysis, once the clean-up of the data collected in field was finished. The data on individuals obtained from Forms 1 and 3 could be inferred, while the obtained from Forms 2 and 4 ensure the real presence of individuals or families in the communities.

Table 1. Sampling sizes.

	Number of families			**Number of individuals**			**Number of individuals who participated in the 1969-1977 longitudinal study**		
	GRUEL	DRINK	**Total**	GRUEL	DRINK	**Total**	GRUEL	DRINK	**Total**
F01. Census (a)			**1,817**	3,353	3,685	**7,038**	784	749	**1,533**
F02. Housing (a)	787	880	**1,667**	-	-	**-**	-	-	**-**
F03. Socioeconomic (b)	389	400	**789**	-	-	**-**	647	622	**1,269**
F04. Anthropometric (b)	-	-	**-**	1,114	1,159	**2,273**	311	363	**674**

(a) Form used for all inhabitants of the four communities.
(b) Form used for the families of individuals participating in the 1969-1977 study.

4. Study Variables

The independent variable is the degree of caloric and protein supplementation of the individuals participating in the 1962-1977 longitudinal study.

The dependent variables in the study are height, primary and secondary schooling completed, economic income, participation of women in its generation,

and well-being measured in terms of the physical possession of goods in the household.

5. Quality of the Data Collected

The anthropometric measurement of weight and height was done according to Loma et al. The forms utilized were validated and the interviewers trained prior to beginning data collection in the field. All the forms were reviewed before being sent for statistical analysis.

6. Statistical Analysis

The double entry of data in Epi Info 6.0 was used for the receipt of forms, while the analysis was conducted in SAS. For hypothesis testing, Chi-square tests were utilized (in order to compare schooling, degree of literacy, possession of goods, and participation of women in the generation of income), and Student-t, Tukey, and F tests were used in the various comparisons of height and income.