Data collection of the INCAP follow-up study: Organization, coverage, and sample sizes

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Abstract

This paper describes the data collection of a follow-up study of subjects who received nutrition supplementation during their early childhood. At the time of follow-up, the subjects were between 10 and 26 years old. The study subjects; the tests, measurements, and interviews made on them; the organization and logistics of the data collection; the training, supervision, and data flow processes; and the teams responsible for the data collection are all described briefly. Coverage rates are shown by village, study area, migration status, sex, and age cohort. Potential biases due to incomplete coverage are discussed.

Introduction

The Institute of Nutrition of Central America and Panama (INCAP) conducted a longitudinal study from 1969 to 1977 in four villages in eastern Guatemala to assess the impact of improved nutrition on child growth and development. Two of the villages received a high-energy, high-protein supplement (*atole*) and two received a low-energy, no-protein supplement (*fresco*).

Data collection in a follow-up study of former participants began in October 1987 with a census of the four villages that had participated in the longitudinal study and another five villages that, during the early phases of the study design, were considered for inclusion in the longitudinal study but were not included because of financial constraints. Of the five, the three villages that were closest in distance to the longitudinal study villages were included in the follow-up.

Census data were collected between 1 October and 1 December 1987, and included general information about the family (e.g., religion, number of family members, characteristics of the dwelling) and about each family member (e.g., birth date, place of birth, migration history, education, and occupation). Follow-up data were collected between May 1988 and June 1989; the census data were updated continuously throughout this period.

Subjects

The follow-up cohort—adolescents and young adults

The principal group included in the follow-up study were the adolescents and young adults who had participated in the 1969–1977 study when they were between the ages of 0 and 7 years (born between January 1962 and February 1977). Records for 2,393 children meeting this criterion were generated from a computer master file prepared jointly by Cornell University and INCAP in 1983. Of these, 224 (9.4%) had died when the follow-up study began, most of them in early childhood. The 2,169 subjects alive in 1988 were the target sample in the supplemented villages.

In addition, adolescents and young adults from three villages that were not part of the longitudinal study (comparison villages) were included. These 929 individuals had lived in the villages between January 1969 and February 1977, according to information obtained in the 1987 census. The total target sample therefore, including subjects from the supplemented and the comparison villages, consisted of 3,098 persons.

At the time of the follow-up study, the adolescents and young adults were between 10 and 27 years old. For simplicity, they are referred to hereafter as the follow-up cohort. The functional domains measured in the entire follow-up included physical growth and body composition, maturation, strength, physical health, and retrospective life history.

Behavioural component sample

Measures of information processing, intelligence, functional competence, and educational achievement

were collected on a subsample of the follow-up cohort. A large number of outcome variables in the behavioural area were of interest; therefore, the time demands for testing each subject were high. To reduce the costs and duration of the study, individuals born between 1962 and 1965 were excluded. They had received supplementation at a non-critical developmental period (ages 4–7 years) and were therefore considered to be of the least theoretical interest.

Work-capacity sample

Measurements of work capacity, bioelectrical impedance, bone density, and physical activity were obtained for a sample of 539 people in the follow-up cohort.

On the basis of the 1987 census, a stratified random sample of 25% of the follow-up cohort was selected. The strata were sex, supplement type (atole, fresco, and comparison villages), and age (<15, 15–17, and >17 years). Migrants were excluded from this sample.

It was anticipated that some subjects would decline to participate, given that the time demanded by the tests was at least half a day. Therefore, an additional stratified sample of 10% of the follow-up cohort was selected for the purpose of replacing subjects from the original sample; this group is referred to as replacements. The rate of participation of the subjects in the original sample of 25% was low, as expected; between 40% and 50% selected in the different villages refused to participate. Therefore, the group finally studied included most of the subjects initially selected as replacements. In some villages, however, the number of replacements was insufficient to meet sample size requirements, and volunteers from the pool of non-sampled adolescent subjects belonging to the appropriate strata were included as additional replacements. The primary reasons for not participating were similar in the atole and the fresco villages: the three principal reasons, accounting for over 80% of the cases, were lack of time (declared by almost 45%), absence from the village when the invitation to participate was made (25%), and medical constraints identified during a physical examination (almost 12%).

Parents of the follow-up cohort

Anthropometric measurements of resident parents of members of the follow-up cohort were obtained. Parental information is useful for interpreting growth patterns in the follow-up cohort. Some anthropometric measurements had been obtained on these subjects during the longitudinal study, particularly the mothers. Thus, the follow-up study was seen primarily as an opportunity to increase the coverage of anthropometric measurements for the fathers. It also provided an opportunity to compare repeated anthropometric measurements of adults who had been measured 11–20 years before, in order to assess the effects of ageing on anthropometric measurements, a consideration in the interpretation of secular change in body size [1].

Retrospective life histories were obtained through interviews with mothers, including ones who had migrated to Guatemala City and to the two towns closest to the study villages, Sanarate and El Jícaro, in order to complete the reproductive histories of the women for the entire reproductive period and to obtain information about events in the families of the follow-up cohort between 1977 and 1988 that could have influenced the outcomes of interest at adolescence. All parents were included, regardless of whether their follow-up cohort child (or children) still lived with them or had formed an independent family.

Wives and heads of households

All wives of men in the follow-up cohort, whether or not they had participated in the longitudinal study, were interviewed for the collection of retrospective life history information.

All heads of households in which at least one of the spouses or dependents was a member of the follow-up cohort were interviewed to obtain information on the income and assets of the family. The sample included the newly formed households as well as the subjects' parents' households. The head of the household was defined as the person who provided the main economic support for the family.

Children

Anthropometric measurements were obtained on all children under five years of age in the seven villages to assess their nutrition status. These data were seen as useful for estimating the degree of secular change in the study villages through comparisons of the results with those collected earlier on the children in the longitudinal study. (This component of the data collection was funded by INCAP.)

Tests, examinations, measurements, and interviews

The follow-up cohort

The following measurements and examinations were made for the follow-up cohort.

Anthropometric measurements included height;

sitting height; weight; biacromial, bicristal, knee, elbow, and wrist breadths; head, arm, waist, hip, thigh, and calf circumferences; and biceps, triceps, subscapular, mid-axillary, suprailiac, anterior thigh, and medial calf skinfolds. Indirect estimates of body composition (fat free mass, percentage body fat) were obtained using predictive equations from a validation study conducted at INCAP as part of the follow-up study.

A clinical examination, conducted by a physician, included a medical history; a detailed physical examination; blood pressure, heart, and respiratory rates; body temperature; and assessment of age at menarche (status quo and history). A vision test was performed, and an examination for signs of vitamin-A deficiency and goitre was made. Abnormalities and diagnosis of diseases were recorded, and treatment was provided when needed.

A blood sample was collected to determine iron status. Hand-wrist radiographs were obtained in males and in non-pregnant females 18 years old and younger, to assess skeletal age by the Tanner and Whitehouse-2 method of rating. (A gravindex test was performed on the urine of females 18 years old and younger who had reached menarche to identify early pregnancies and avoid exposure to radiation.) Hand strength was measured for the right and left hands using a dynamometer.

Members of the follow-up cohort and their spouses were interviewed for the collection of retrospective life history information. The women's life histories included information about current reproductive status, parity, gravity, a detailed reproductive history (the outcome of every pregnancy, birth dates of newborns, mortality, feeding mode at time of death, prenatal care, and delivery care), breastfeeding and weaning practices for any child in the last five years, and contraceptive use; they also covered marital/union status and history, education, occupation, migration history, and the characteristics of the dwellings where the women had lived. The men's life histories included income, occupation, education, and migration as well as some information about accumulated wealth, and also covered marital/union status and information on dependents, including their ages and sexes. Information from school records was recorded, including age at first enrolment, grades attended, attendance rate, and test scores.

Behavioural component sample

In addition to these measurements, examinations, and interviews, the behavioural subsample participated in three sets of tests. An information processing test, using a microcomputer with programmes designed specifically for this study, included tests of simple and choice reaction time, a short memory task, and a paired associates test. Functional performance was assessed by a battery of tests of literacy and numeric and general knowledge, and two standardized educational achievement tests of reading and vocabulary; the latter are part of an inter-American series used extensively in Guatemala by faculty from the Universidad del Valle in Guatemala City. Intelligence was assessed with the Raven's standard progressive matrices.

Work-capacity sample

Physical work capacity was determined as the oxygen consumption at maximum physical exertion (VO_2 max) on a motorized treadmill. Besides this test, measurements of bioelectrical impedance and bone density were performed using photon absorptiometry. Physical activity was investigated through a questionnaire.

Parents of the follow-up cohort

Anthropometric measurements were taken for the parents of the members of the follow-up cohort. For the men these were height; sitting height; weight; head, arm, waist, hip, thigh, and calf circumferences; and biceps, triceps, subscapular, anterior thigh, and medial calf skinfolds. For the women they were height; sitting height; weight; biacromial, bicristal, knee, elbow, and wrist breadths; head, arm, waist, hip, thigh, and calf circumferences; and biceps, triceps, subscapular, mid-axillary, suprailiac, anterior thigh, and medial calf skinfolds.

Retrospective life histories, identical to those for the follow-up subjects, were obtained by interview. A detailed questionnaire regarding family income during the previous year as well as accumulated assets over the years was completed for the heads of households. The information obtained included land tenure, crops produced, agricultural inputs (including labour, production, and operation costs), time spent in agricultural jobs by product and family member, production, revenue, and income from agriculture and other sources, and an inventory of livestock ownership.

Children

The following anthropometric measurements were taken for preschool children: length; crown–rump length; weight; knee breadth; head, arm, and calf circumferences; and biceps, triceps, subscapular, mid-axillary, and medial calf skinfolds.

TABLE 1. Field personnel

Team and number of personnel	Area
Follow-up cohort (two teams)	
2	anthropometric measurements, X-rays, hand strength
1	medical examination
2	functional competence and intelligence
1	information processing
1	life history
1	logistics supervisor
1	school records (M.S. student)
Parents and heads of households	
3	life history
2	income and wealth
2	anthropometric measurements
Children	
2	anthropometric measurements
Work capacity	
1	M.D.
1	nutrition Ph.D. candidate
1	medical student
1	nurse
2	nutrition M.S. students
Migrants	
1	supervisor
2	field workers

Organization and logistics of the data collection

Personnel

Six working teams conducted the tests, examinations, measurements, and interviews (table 1).

Two teams, of eight field workers each, collected data on the follow-up cohort, operating from a central location. Two were anthropometrists who, in addition to the anthropometric measurements, performed the hand and wrist radiographs and the hand-strength test. A physician conducted the medical examination and collected blood and urine samples. Three psychometrists were in charge of administering the behavioural tests: two for functional performance and intelligence and one for information processing. One enumerator conducted the life history interviews for both men and women, including the wives of adolescent men.

A logistic supervisor was in charge of coordinating the flow of subjects through the different tests, examinations, and measurements and was also responsible for identifying the subjects who would participate each day. He was assisted by two community workers in each village, who were in charge of visiting the subjects selected for study one day in advance and inviting them to attend the centre where the teams were located. In addition, one master's degree student from the University of California at Davis collected the school performance data from school records, with support from the behavioural component team.

Three enumerators conducted the life history interviews with the mothers of the follow-up cohort. They received help from the two enumerators who conducted the life history interviews with the follow-up cohort. Most of the data were collected through household visits. Two enumerators gathered income and wealth data on the heads of households through home visits. Two anthropometrists did the anthropometric measurements on the parents, using a combination of home visits and measurements at the central location.

Two anthropometrists made the anthropometric measurements on preschool children, generally at the central location but occasionally during home visits.

The work-capacity team consisted of a physician and a nutritionist, both with training in exercise physiology, a medical student, and a nurse. In addition, two master's degree students from Cornell University joined the team for a few months. The team operated in a physiology laboratory, which, with one exception (Espíritu Santo), was not located in the study villages because of a lack of appropriate facilities; the subjects were transported to the laboratory where the tests were performed.

A special team, consisting of a supervisor and two field workers, was put together to locate migrants and organize the collection of data from them. Only subjects who were known to have migrated to Guatemala City, Sanarate, or El Jícaro were included in the follow-up study.

Coordination and supervision

A technical coordinator (J. Rivera) was responsible for the overall coordination of the project. A field director (H. Castro) was in charge of the day-to-day coordination of the field work and also supervised the anthropometry data collection, the hand and wrist radiographs, and the medical examinations. The coordinator and supervisor of data collection for the behavioural component was Kathleen Gorman. Beth Conlisk and Elkin Martínez were in charge of the work capacity test, coordination of the bioimpedance and bone density examinations, and the

physical activity questionnaire. In addition, three field work supervisors with extensive experience at INCAP were hired to supervise the life history interviews (Marta Amanda Barrera), income and wealth data collection (Victor Mejía-Pivaral), and the study of migrants (Elena de Ramírez).

Logistics

Rotation of teams

The data-collection teams rotated among the villages, following the programme outlined in table 2. Data were collected simultaneously in two villages. The second and third columns give the locations of the two follow-up cohort teams during each week of the study. The first column under "Work capacity" indicates the location of the laboratory and the second the villages of origin of the participating subjects. The last three columns give the locations of the adults teams each week.

The purpose of rotating the teams was to diminish biases due to measurement differences between teams; therefore each team collected data in all the villages. Also, the data collection in each village was staggered over the duration of the study to coincide with both the rainy and the dry season.

The work-capacity laboratory was moved according to the rotation programme. It needed to be where there was adequate space, electricity was available, and air-conditioning could be installed. The closest locations where these conditions could be met were selected: the town of Sanarate for four of the villages in the western part of the province, and Espíritu Santo, one of the supplemented villages, for itself and one of the comparison villages. The laboratory was moved between these two places twice during the study. At the end it was moved to Guatemala City, where children from El Caulote, another comparison village, performed the tests; this was the only village for which the work-capacity data were collected in one stretch of time.

Programme of appointments

Lists of the target samples for participation in the various tests, measurements, and interviews were generated from the INCAP-Cornell master file. The families of the follow-up cohort members in the target sample were selected randomly for participation during the first or the second visit of the working teams to their village. The supervisors instructed the two community workers in each village to visit the individuals listed and invite them to be study subjects. The follow-up subjects were scheduled to complete all tests, measurements, and interviews in three visits. In practice, however, most chose to complete the entire battery in two days and in some cases in one day.

On arrival at the centre, the subjects received an explanation about the assessments in which they would participate. The person giving this explanation coordinated the flow of subjects into the different study areas. When possible, the behavioural tests were performed before the medical examination, which involved collection of a blood sample, since this caused anxiety in some of the subjects. When possible, the behavioural tests were spread across visits to avoid loss of attention due to fatigue.

The typical durations of the procedures conducted with the follow-up cohort were as follows: anthropometric measurements, hand-wrist radiographs, and hand-strength tests, 25 minutes; medical examination and collection of urine and blood samples, 25 minutes; functional competence and intelligence tests, 60 minutes; and life history interview, 20 minutes. In general, the subjects tolerated the time involved better than had been expected.

A few follow-up subjects who refused to attend the centre but were willing to participate (3.6%) were visited at their homes, where the tests and measurements—except for the radiographs and the information-processing test, both of which required the use of equipment that could not be transported—and the interviews were carried out. Most of the income and wealth interviews of heads of households and many of the life history interviews of mothers and the anthropometric measurements of the parents of members of the follow-up cohort were carried out at their home, since these subjects had less time to attend the centres.

The teams worked approximately eight hours a day on flexible schedules depending on the preferred hours of participation of the subjects in each village and season. In some villages and seasons, work was from 8 a.m. to 5 p.m., and in others it was as late as between noon and 9 p.m. In all the villages, the teams had to work some weekends in order to allow for the participation of subjects who worked in the field until late afternoon on weekdays or who worked out of the village during the week and returned on weekends and migrants who visited their families on weekends.

Training, supervision, and data flow

Training

Training took place in February and March 1988. Project staff and, in some cases, experts hired as consultants were in charge of training the field personnel in the different areas. A detailed description of those who were in charge of training is available elsewhere [2].

The final stage of training included standardization

TABLE 2. Data collection schedule, May 1988–May 1989

				Work capacity		Adults		
		Team I	Team II	Lab. location	Village	Anthro-pometry	Life history, income & wealth	
May	16–22	Conacaste	S.Domingo			Conacaste	S.Domingo	Conacaste
	23–29	"	"			"		
My/Je	30–5	"	"			"		
June	6–12	"	"	Sanarate		S.Domingo		
	13–19	"	"	"	Conacaste			
	20–26	"	San Juan	"	S.Domingo	San Juan	San Juan	
Je/Jl	27–3	"	"	"	San Juan			
July	4–10	"	"	"		Conacaste		
	11–17		"	"	Subinal	San Juan	Subinal	
	18–24	Subinal		"		Caulote		Caulote
	25–31	"	Caulote	"		"		
Aug	1–7	"	"			"		
	8–14	"	"			"		
	15–21		"			"		
	22–28	Ovejas	Esp.Santo					
Ag/S	29–4	"	"	Esp.Santo		Esp.Santo	Esp.Santo	Ovejas
Sep	5–11	"	"	"	Ovejas	Ovejas		
	12–18	"	Guatemala	"	Esp.Santo			
	19–25	San Juan		"		San Juan	San Juan	
S/O	26–2	"	Conacaste	Sanarate		"		
Oct	3–9	"	"	"		"		Conacaste
	10–16	"	"	"	Conacaste	"		
	17–23	"	"	"		Conacaste		
	24–30		"	"	S.Domingo	"		
O/N	31–6	Sanarate	"	"	San Juan	"	S.Domingo	Sanarate
Nov	7–13	S.Domingo	"	"	Subinal			
	14–20	"	"	"		Subinal		Subinal
	21–27	"	Subinal	"				
N/D	28–4	"	"	"				
Dec	5–11	"	"	"				
	12–18		"	"				
	19–24	VACATION						
D/Ja	25–1	"						
Jan	2–8	Esp.Santo	Ovejas			Esp.Santo	Esp.Santo	Ovejas
	9–15	"	"					
	16–22	"	"					
	23–29	"	"	Esp.Santo		Subinal		
Ja/F	30–5	"		"				
Feb	6–12	"	Guatemala	"	Ovejas			
	13–19	"	"	"	Esp.Santo			
	20–26	Guatemala	Ovejas	"				
F/Mr	27–5	"	"	"				
Mar	6–12	Caulote	Guatemala	Guatemala		Caulote	Caulote	
	13–19	"	Home visits	"				
	20–26	"	"	"	Caulote			
Mr/Ap	27–2	"	"	"		S.Domingo		
Apr	3–9	"	"	"				
	10–16	"	"	"				
	17–23	"	"	"				
	24–30	"		"			San Juan	
May	1–7	"	"	"				Subinal
	8–14	"	"	"				
	15–21	"	"	"				Conacaste
	22–28	"	"					S.Domingo

Atole villages: Conacaste, San Juan. Fresco: Santo Domingo, Espíritu Santo. Comparison: Subinal, Las Ovejas, El Caulote. Data collection in Guatemala City and Sanarate (except in the case of the work-capacity laboratory) was for migrants from the villages.

exercises in anthropometry and in administering the functional performance tests, the income and wealth questionnaire, and the life history questionnaire. In the anthropometry training exercise, the levels of technical errors of measurement obtained were as good as or better than those reported in the literature. For the life history and the income and wealth questionnaire as well as for the functional performance tests, the percentages of agreement between interviewers were in general above 95% [2].

Supervision and quality control

Supervision of the anthropometric measurements, radiographs, hand-strength tests, medical examinations, life history interviews, and behavioural tests was continuous. The supervisors spent at least two or three days per week in the field, providing direct supervision to the field workers and examining and correcting the data-collection forms weekly. Efforts were made to identify obvious coding errors, consulting with the field workers who had collected the data, and correcting them when possible.

When errors were suspected in anthropometric measurements, the anthropometrist responsible for data collection was asked to repeat the measurement. The supervisor then compared the measurements and specified which value to accept. This supervision involved direct observation of the technique and review of the data-collection forms. Ranges of permissible values were used to detect outliers; then, either obvious errors were corrected or the subject was re-examined. The tests in the behavioural area and the life history interviews required more privacy; therefore, supervision for those areas was done only through review of the data forms.

The supervisor of the income and wealth data collection visited the field less frequently because of other commitments. In this area, the two enumerators exchanged data forms after interviews were conducted. Apparent discrepancies or coding errors were discussed.

In the work-capacity area, the supervisors participated directly in the data collection. After each test, the team reviewed the results and so detected and corrected obvious errors.

Repeated measurements were made in a subsample of the subjects in order to establish reliability. The percentages of subjects remeasured were as follows: 10.3% for anthropometry, 3.9%–4.6% for the behavioural tests, 4.3% for work capacity, and 2%–5% for the life histories and income and wealth questionnaires.

Detailed analysis of the reliability of the anthropometric measurements is presented elsewhere [3]. The reliability values were above .91 for all the anthropometric measurements. The intra-measurer reliabilities were above .96 in all measurements, and the inter-measurer reliabilities were above .98 in most measurements. These values are considered satisfactory.

Test-retest stability coefficients and internal consistency measures of the psycho-educational tests were in general similar to published results and are considered satisfactory. Some variables of the information-processing tests with low stability coefficients were dropped from the analysis. Differences between testers were large in many cases; however, analysis before and after controlling for tester effects showed similar results. Tn summary, reliability was found to be acceptable for key psycho-educational variables.

Data flow, entry, verification, and cleaning

After thorough revision and correction of the data forms, the data were key-punched twice at the INCAP computer centre. They were then cleaned using valid ranges of values to detect outliers suspected to be errors and also using consistency checks across variables. Finally, computer files were prepared for data analysis. Values suspected to be incorrect were sent back to the field, where the supervisor of each area corrected coding errors. In the areas of anthropometry and life history, when errors other than coding were found, the subjects were re-examined.

Primary health care activities

The study imposed time demands on and caused some inconvenience for the subjects. Since the principal objective was to study the long-term effects of undernutrition and supplementary feeding, the study was of little direct benefit to the people of the communities in improving their nutrition status and health. Consequently, it was considered necessary to contribute directly to the welfare of the villages, and a primary health care programme was established for this purpose. To avoid its dependence on the project, it was implemented in coordination with local clinics run by the Ministry of Health in five of the seven villages.

A paediatrician with a master's degree in public health and nutrition was in charge of the programme. The emphasis was on maternal and child health care, but it provided medical attention to persons of all ages in all the study villages. The project donated a supply of drugs that were needed in the clinics run by the Ministry of Health, and the paediatrician provided training to the nurses in the ministry's child survival programme. In the two villages without clinics, the project established clinics in

buildings donated by the communities and hired a nurse to staff them. The paediatrician visited each village once a week and examined and gave medical attention to children identified by the nurses as requiring medical care as well as all those who came to the clinic; he also used these cases as opportunities to train the nurses.

In addition, campaigns were organized in collaboration with dentists from the University of San Carlos for the provision of dental care.

At the end of the project all the medical equipment was donated to the communities where the new health centres had been established.

Coverage rates

Coverage is defined as the rate of participants per target sample. The target samples for the different age groups and study areas were defined prior to the field work. Participants in the follow-up study were defined as subjects for whom data were available for at least one study area.

Table 3 shows the distribution of the 2,169 subjects in the follow-up target sample in the supplemented villages and the 929 in the comparison villages. Overall coverage was 71.7%, ranging from 65.9% to 76.1% in the different villages. The rates were slightly greater for the supplemented villages (72.6%) than for the comparison villages (69.5%). They did not differ significantly between the atole and the fresco villages.

TABLE 3. Overall coverage of the follow-up cohort

	Target sample	Participants	Coverage (%)
Supplemented			
—fresco			
Santo Domingo	594	411	69.2
Espíritu Santo	423	322	76.1
—atole			
Conacaste	675	488	72.3
San Juan	477	353	74.0
All supplemented villages	2,169	1,574	72.6
Comparison			
Subinal	238	165	69.3
Las Ovejas	386	280	72.5
El Caulote	305	201	65.9
All comparison villages	929	646	69.5
All villages	3,098	2,220	71.7

Coverage rates were greater for females (74.5%) than for males (68.9%); this pattern was similar in the supplemented villages (females, 799/1,060 = 75.4%; males, 775/1,109 = 69.9%) and the comparison villages (females, 343/473 = 72.5%; males, 303/456 = 66.4%).

The coverage rates for migrants differed between the supplemented and the control villages (table 4). Among members of the follow-up cohort living in

TABLE 4. Coverage of the follow-up cohort by migration status

	Migrants			Non-migrants		
	T	P	%	T	P	%
Supplemented						
—fresco						
Santo Domingo	212	79	37.3	382	332	86.9
Espíritu Santo	138	66	47.8	285	256	89.8
—atole						
Conacaste	201	80	39.8	474	408	86.1
San Juan	176	71	40.3	301	282	93.7
All supplemented villages	727	296	40.7	1,442	1,278	88.6
Comparison						
Subinal	61	28	45.9	177	137	77.4
Las Ovejas	98	44	44.9	288	236	81.9
El Caulote	76	33	43.4	229	168	73.4
All comparison villages	235	105	44.7	694	541	78.0
All villages	962	401	41.7	2,136	1,819	85.2

T = target sample; P = participants; % = coverage.

the villages at the time of the follow-up (non-migrant subjects), the rates were about 10% greater in the supplemented (88.6%) than in the comparison villages (78.0%)—probably as a result of the good rapport built by INCAP over the nine years of the longitudinal study. But the rate of participation for migrants was slightly less for the supplemented villages (40.7%) than the comparison villages (44.7%). This may be due to differences in how the target sample was defined for the two types of villages: The target sample of migrants from the comparison illages was identified using information from the 1987 census. Therefore, only adolescent migrants whose families were still living in the villages at the time of the follow-up census were selected. In contrast, the target sample for the supplemented villages was identified on the basis of records from the longitudinal study and thus included some whose entire families had migrated before the beginning of the follow-up study. Some of these families were located through information provided by neighbours and relatives; in the absence of parents or close relatives still living in the village, however, these target subjects were much more difficult to trace. Therefore, the coverage rates for migrants from the supplemented and the control villages are not equivalent.

The coverage rates for migrants were much lower overall than those for non-migrants both because of the difficulty of locating migrants and because the data collection was restricted to three cities. The target samples in table 4 include all migrants, regardless of their location at the time of the follow-up study. However, as already mentioned, the data collection was restricted to those who were known to have migrated to Guatemala City or one of the two towns nearest to the study villages, because of resource restrictions and the fact that information available at the beginning of the study indicated that about 64% of the migrants for whom locations were known lived in one of these three locales. Coverage for migrants to these three places was 62%; for all migrants, it was 42%.

The coverage rates for females were greater than for males among both migrants and non-migrants. For migrants, the rates were 45.6% and 36.9% for males and females respectively; the pattern was similar in both the supplemented villages (females, 176/394 = 44.7%; males, 120/333 = 36.0%) and the comparison villages (females, 65/134 = 48.5%; males, 40/101 = 39.6%). Among non-migrants the coverage was 89.7% for females and 81.2% for males; again the rates were greater for females in both the supplemented villages (females, 623/666 = 93.5%; males, 655/776 = 84.4%) and the comparison villages (females, 278/339 = 82.0%; males, 263/255 = 74.1%).

The subjects were classified into four birth cohorts with different ages of exposure to supplementation. Cohort I was made up of children born from March 1974 on; these children were partially exposed to supplementary feeding during their first three years of life, considered the most critical period in terms of the potential effects of supplementary feeding. Cohort II, the group born between March 1969 and February 1974, was fully exposed to supplementation during the critical period from birth to 3 years of age and partially exposed from 4 to 7 years of age. Cohort III, born between January 1966 and February 1969, was partially exposed to supplementation from 1 to 3 years of age and fully exposed between the less critical ages of 4 and 7 years. Finally, cohort IV, born before 1966, was partially exposed to supplementation from 4 to 7 years of age. In general, cohort I has the highest coverage rates, followed by cohorts II, III, and IV (table 5). Younger subjects may have had more time to participate in the various tests and interviews than older subjects.

Table 6 presents the coverage rates for the different study domains by village type. The rates were around 70% for most domains. The rates in the comparison villages generally were slightly lower than in the supplemented villages but followed the same patterns. For the work-capacity test, more subjects than originally planned were examined in the comparison villages.

The low coverage for blood collection deserves comment. From the early stages of the study, some members of the field team suspected that many subjects who had refused to participate in the study did so as a result of anxiety regarding the procedure. This was substantiated by a team of supervisors with substantial experience in field work who interviewed subjects who had refused to participate and their families. Some subjects felt that the very small amount of blood collected (5 ml) was very large relative to the total blood volume in an adult. In one village, a rumor was circulated that the blood was being sold for a profit. A decision was made to make it clear at the time subjects were invited to participate in the study that blood collection was not essential for participation in the rest of the tests, measurements, and interviews. In addition, the subjects were informed that the blood samples were also used for the diagnosis of anaemia and that treatment would be provided when it was needed. After those messages began to be communicated at the time of the invitation, the number of refusals to participate declined, although refusals to provide a blood sample rose.

Other strategies were also used to increase the coverage rates. For example, the coverage of males was low in one of the villages. A large number of adolescents refused to participate even though they

TABLE 5. Percentage coverage of the follow-up cohort by birth cohorts and sex

	Females				Males			
	I	II	III	IV	I	II	III	IV
Supplemented								
—fresco								
Santo Domingo	84.1	73.0	56.4	68.8	82.3	70.9	61.5	50.0
Espíritu Santo	90.4	74.4	65.9	69.2	87.5	77.3	55.8	62.1
—atole								
Conacaste	84.8	74.1	79.4	81.4	87.5	65.7	55.8	53.8
San Juan	76.3	79.0	67.9	67.9	90.8	74.0	58.5	57.1
All supplemented villages	83.8	75.1	67.9	73.1	87.1	71.2	60.3	54.5
Comparison								
Subinal	89.2	83.3	54.2	58.3	90.9	67.4	46.7	42.9
Las Ovejas	83.8	81.2	64.7	66.0	85.7	81.4	61.9	49.0
El Caulote	87.8	76.6	55.2	47.6	91.7	70.6	38.5	42.4
All comparison villages	87.0	80.4	58.6	57.5	88.8	73.7	51.8	45.5
All villages	84.8	76.6	65.2	67.5	87.6	71.9	57.9	51.2

See text for definitions of birth cohorts I–IV.

TABLE 6. Coverage of the follow-up cohort by study domain and village type

	Supplemented			Comparison		
	T	P	%	T	P	%
Anthropometry	2,169	1,554	71.7	929	633	68.1
Medical examination	2,169	1,543	71.1	929	630	67.8
Hand-wrist X-rays	1,149	920	80.1	459	337	73.4
Blood sample	2,169	1,196	55.1	929	425	45.7
Psychology tests						
functional competence and intelligence	1,897	1,367	72.1	766	532	69.5
information processing	1,897	1,331	70.2	766	521	68.0
Life history						
men	1,109	742	66.9	456	282	61.8
women	1,060	730	68.9	473	311	65.8
Work-capacity	388	361	93.0	152	178	100.0[a]

T = target sample; P = participants; % = coverage.

a. More subjects were examined than originally planned.

had no apparent time constraints. It was common to see individuals who had refused to participate standing in a park across the street from the centre where the tests, measurements, and interviews took place, teasing those who had agreed to participate. The staff realized that a large number of the refusers played soccer, and so a soccer championship was organized in the village by INCAP, including all teams in the village, and this had a positive effect in raising the coverage rates.

The coverage rate for the anthropometric measurements of the parents of the follow-up cohort was 82.4%, with no difference between the supplemented (809/979 = 82.6%) and the comparison villages (386/472 = 81.8%). Similar rates were obtained for the life histories of the mothers (82.7% overall; supplemented, 452/543 = 83.2%; comparison, 207/253 = 81.8%). In contrast, the coverage of the income and wealth questionnaire given to the heads of households was lower (62.0%) but was also similar in

TABLE 7. Early childhood characteristics of participants and non-participants in the follow-up study from the supplemented villages born March 1969–February 1974

Variable and village type	Participants			Non-participants			T value	P value
	N	Mean	SD	N	Mean	SD		
Birth weight (kg)								
atole	278	3.11	0.49	79	2.95	0.46	2.50	.01
fresco	236	3.01	0.79	63	2.93	0.46	1.12	.26
total	514	3.06	0.48	142	2.94	0.46	2.58	<.01
Weight at 3 yrs (kg)								
atole	316	12.3	1.3	65	12.0	1.4	1.61	.11
fresco	296	11.4	1.3	51	11.6	1.1	1.16	.25
total	612	11.8	1.4	116	11.8	1.3	0.14	.89
Height at 3 yrs (cm)								
atole	316	86.4	3.8	65	85.4	4.0	1.95	.05
fresco	296	84.6	3.9	51	84.9	3.7	0.57	.57
total	612	85.5	3.9	116	85.2	3.8	0.84	.40
Diarrhoea 0–3 yrs (%)								
atole	375	8.5	8.3	136	14.6	17.7	3.88	<.01
fresco	349	8.9	7.8	112	7.7	7.8	1.43	.15
total	724	8.7	8.1	248	11.5	14.5	2.88	<.01
Supplement 0–36 mos (kcal/day)								
atole	403	106	87	136	65	80	4.79	<.01
fresco	373	16	16	110	9	13	4.78	<.01
total	776	63	78	246	34	66	4.47	<.01
Home diet 15–36 mos (kcal/day)								
atole	337	697	210	68	746	210	1.74	.08
fresco	312	723	234	54	747	205	0.73	.47
total	649	709	222	122	747	207	1.71	.09

the supplemented (62.5%) and the comparison villages (60.7%); these low rates were due in part to the long time required to obtain the information and the fact that most of the heads of households worked in agriculture and were away from home most of the day.

Potential bias due to incomplete coverage

Table 7 presents descriptive statistics of key variables collected during the longitudinal study, when the subjects were between the ages of 0 and 36 months. As noted earlier, this information is available only for the supplemented villages. For all the villages combined, the participants in the follow-up study had somewhat greater birth weights, greater supplement intakes, and lower percentages of time with diarrhoea than non-participants. For all the other variables they were similar. The greater supplement intakes among the participants indicate that the subjects in the follow-up study had higher rates of participation in the supplementary feeding programme during the longitudinal study. The heavier birth weights among the participants, although not statistically significant, suggest that their mothers also participated more in the supplementary feeding programme, because maternal supplementation during pregnancy was related to birth weight. The fact that the participants had lower prevalences of diarrhoea, which was shown to be unrelated to supplementation, suggests that the sanitary conditions during the longitudinal study were worse for non-participants than for the participants of the follow-up study.

Examination of patterns in both the atole and the fresco villages indicates that supplement intake during the longitudinal study was higher in the participants in the follow-up study than in non-participants, although the energy intakes from fresco were small. The lower prevalence of diarrhoea during early childhood among the participants was restricted to the atole villages; also, the higher birth weights

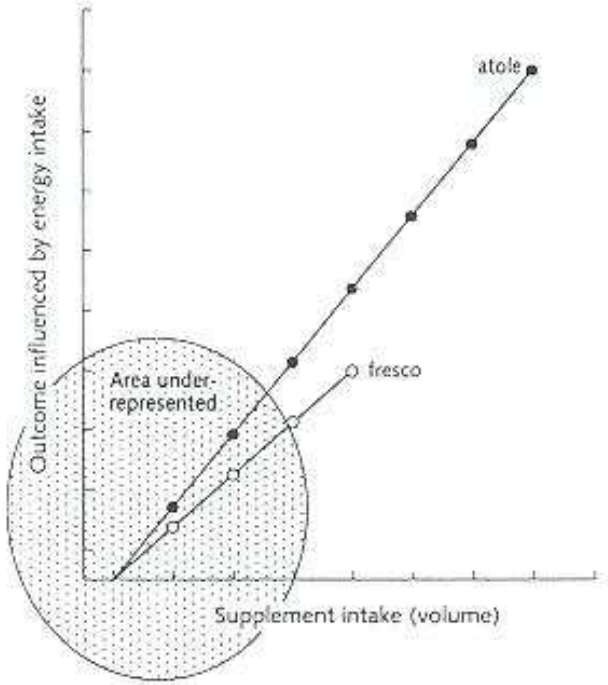

FIG. 1. Schematic representation of biases resulting from self-selection of participants for different types of outcome

among the participants were more pronounced in the atole villages.

The differences found between participants and non-participants may or may not bias analyses of the effects of supplementation, depending on the specifics of the different domains studied. Therefore, the potential biases should be judged for each particular domain. For domains in which the effect of the supplementation programme is mediated through energy or protein, the fact that those with higher intakes are over-represented in the follow-up sample studied would, in theory, tend to overestimate the effect, because the differences in energy and protein intakes between atole and fresco increased as the volume of supplement ingested increased (fig. 1). This may also be the case if effects are thought to be mediated through vitamins or minerals. Although the content of these nutrients by volume was similar in both drinks, the volume of atole ingested was on the average two to three times greater than that of fresco during the first three years of life. This fact is represented in the figure by the shorter line corresponding to the fresco group. One way of dealing with differences between participants and non-participants is to apply econometric techniques that adjust for sample selectivity as recommended by Heckman [4].

Concluding remark

The follow-up study was carried out in a timely manner, a tribute to INCAP's ability to plan, staff, and execute field studies. State-of-the-art methods were used, and rates of coverage were equal to or higher than generally obtained for studies of its type. The data have been cleaned and summarized for analysis. The tasks that remain include analyses, interpretation, and dissemination of the results of this ambitious study.

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