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Agency For International Development
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Results of the Field Studies

Food Wastage/Sanitation Cost-Benefit
Methodology Project (AID/csd-2959)

Submitted by

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I. Introduction

The University of North Carolina at Chapel Hill and the Institute of Nutrition of Central America and Panama have cooperated in an Agency for International Development sponsored project on "Food Wastage/Sanitation Cost-Benefit Methodology." The project was directed to the study of the environment (water supply, sanitation), the impact of health education, diarrheal morbidity and food wastage (through intestinal malabsorbtion) and the relationships between these variables.

The contract with A.I.D. requires the contractor to develop, field test and prepare a manual describing a methodology which could be utilized to determine the economic relationship between different levels of improved environmental sanitation and the waste of food energy. The waste of food energy was determined by measuring the efficiency of absorption of food in the intestinal tract. This was expected to be related to the prevalence of those intestinal diseases which are transmitted under unsanitary conditions.

Three major reports are required to describe and give the findings of the several phases of the project. These include:

a) A Methodology Report which describes the background of the project, the design of the field trial, and presents a detailed description of the methodology that has been tested in two Guatemalan rural communities. The Methodology Report has been prepared along with an appendix containing the forms used in the project and detailed protocols. The draft Methodology Report (August 31, 1977) is available, A final edited version will be ready by March 31, 1978.

b) A Report of the Scientific Results of the Field Trials. This report includes the details of data analysis and the results of the field

studies with their interpretation.

c) A final Report on the Significance of the Findings to planners in Guatemala and other Less Developed Countries, as well as a manual describing a simplified methodology for future studies in the LDC's, is in preparation.

This report on the scientific results of the field trials has two objectives:

1) To provide a detailed presentation of the data and results of the field trials.

2) To test the methodology that was used in the study and which will provide the basis for evaluation and development of a simplified or alternate methodology. This objective will be dealt with in the final report of the study scheduled for June 30, 1978.

The first objective is presented here and should be considered in light of the constraints and methodological limitations which existed in the field. A current evaluation of the problems inherent in studying water/health relationships are discussed in the Report of an Expert Panel on "Measurement of the Health Benefits of Investments in Water Supply" to the I.B.R.D. (Jan 1976).

Those readers who seek data which establishes a linkage between water supply and sanitation on one side and a decrease in diarrheal disease and improvement in intestinal absorption on the other, will be disappointed. However, significant guides for future studies and insights into the dynamics of morbidity, malabsorption, and health behavior modification which flow from improvements of water supply and sanitation are presented.

The possibility and limitations of using field studies to determine outcomes in specific objectives such as the economic relationship between

different levels of improved environmental sanitation and waste of food energy are made clearer through these field trials. However, the overriding conclusion, which should be considered in any future studies, is to approach these complex questions through more limited studies in which the time frame is compatible with the objectives. Further, biological linkages should be experimentally established outside of the context of any such study. In sum, four years of field trials are not sufficient to measure the social and biological changes which might result in an improved health status. The relationship between malabsorption and water supply will not be demonstrable until the linkage between water supply/diarrheal morbidity/malabsorption is established.

II. Village Comparisons

The environmental and demographic characteristics of the two study villages, Guanagazapa (experimental) and Florida Aceituno (control), were not static during the forty-two month study. The principal objective for using a control village was to track internal and external changes in health status, behavior and the community environment which presumably would have occurred even in the absence of any large scale intercession. In addition to expected changes over time, the mere presence and activities of the study staff could have stimulated some of the changes. Measurement of both physical and behavioral changes were part of the study design in the experimental village.

Historical and geographical characteristics of the two villages were given in some detail in the Methodology Section (Volume I) of the report.

Demography

A monthly census was used to quantify the population dynamics in each village. Detailed census information is presented in the Appendix. The population of both villages by family, age category and sex at the beginning and end of the study period is given in Table II.1. These statistics illustrate the demographic comparability of the two villages.

TABLE II.1
Village Populations by Age and Sex

	Guanagazapa		Florida Aceituno	
Characteristic	May 73	August 76	May 73	August 76
0 - 1 years	45	42	37	52
1 - 7 years	203	218	170	199
7+ years	769	837	656	755
Number of males	528	566	469	535
Number of females	489	531	394	471
Number of families	202	238	199	210
Total population	1017	1097	863	1006

Family size is a variable which has implications for computing crowding statistics, changes and needs in household sanitation, and the relationship to disease incidence. A significant relationship between family size and morbidity was observed. This relationship will be examined in some detail in a later chapter. The family structure of the villages is presented in Table II.2.

TABLE II.2

Village Population by Family Size in May 1973

	Number of Families Present			
Family Size	Guanagazapa	Percent of Total	Florida Aceituno	Percent of Total
1	19	9.4	16	8.0
2	17	8.4	34	17.1
3	28	13.9	37	18.6
4	27	13.4	29	14.6
5	24	11.8	25	12.6
over 5	87	43.1	58	29.1
Total	202	100.0	199	100.0

The populations in these villages were more mobile than was anticipated (Figures II.1 and II.2). Some of the mobility in Guanagazapa can be explained by the absence of adult males for extended periods for occupational reasons. However, there was also considerable in and out migration. This mobility may have implications, particularly in Guanagazapa, for the reporting of disease incidents and on the impact of environmental exposures such as water quality and household sanitation. Figures II.1 and II.2 give the dimensions of these population dynamics. No attempt was made in this study to determine why an individual or family moved

FIGURE II.1

Dynamics of Births, Deaths and Migration In Guanagazapa

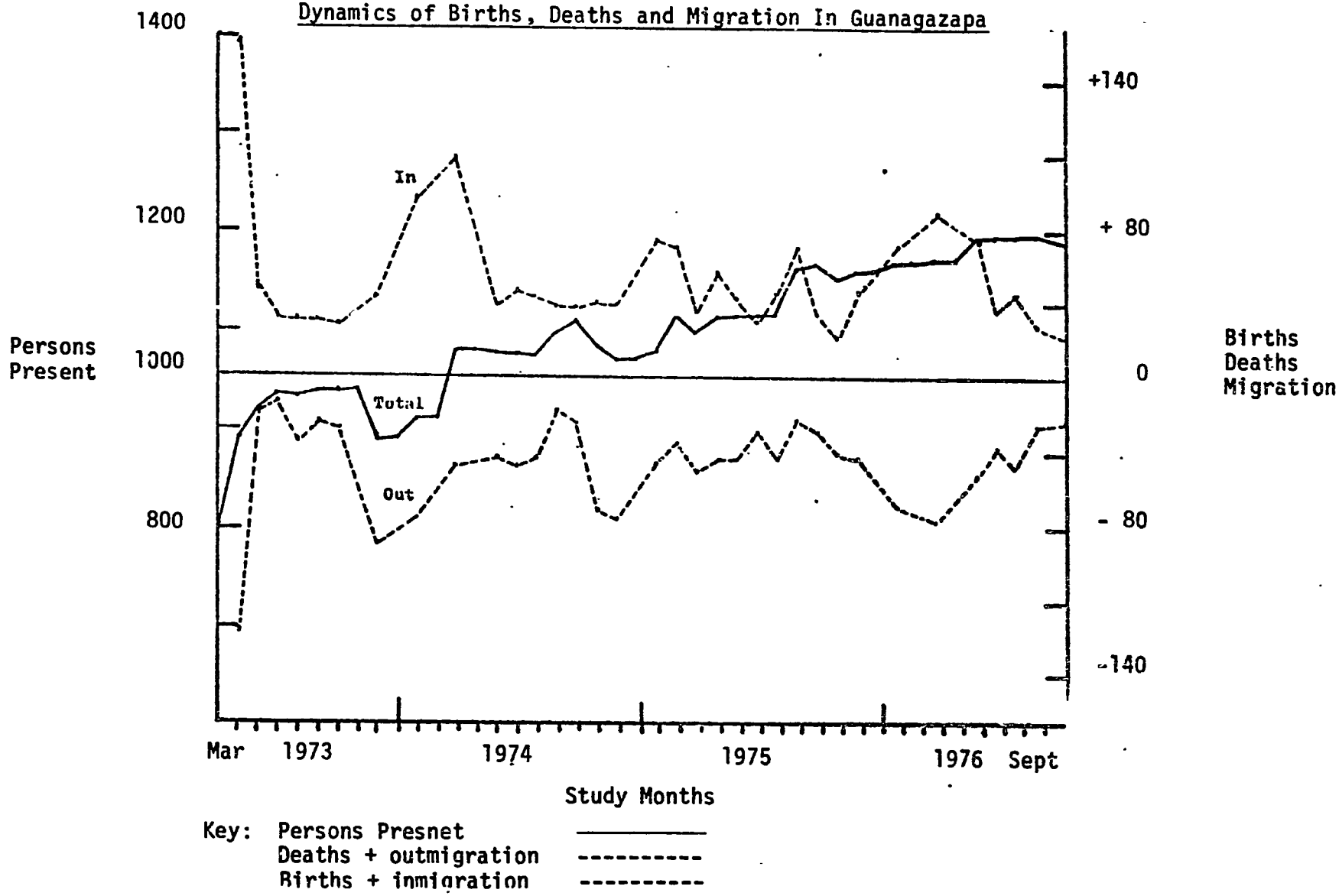
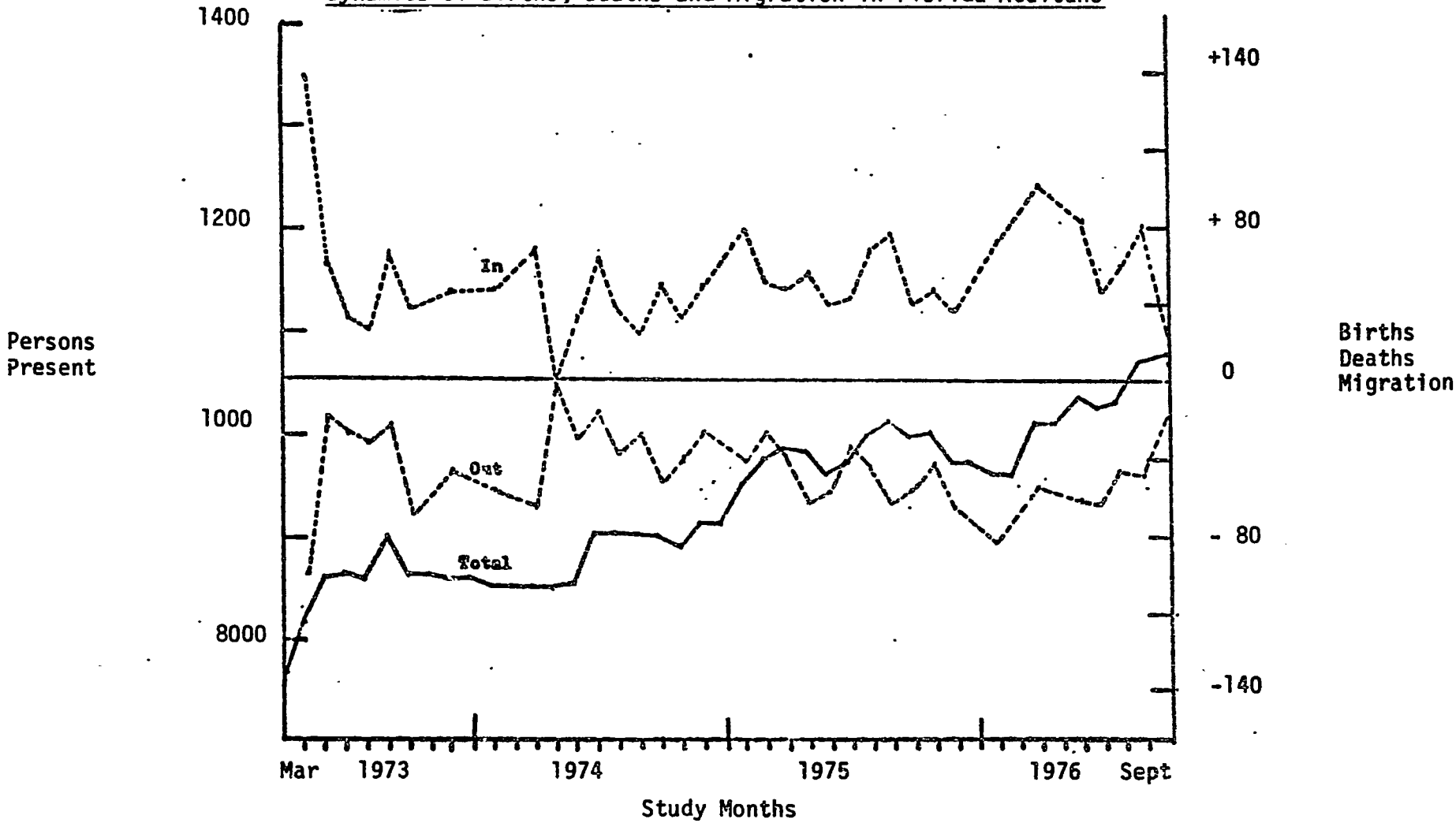


FIGURE II.2

Dynamics of Births, Deaths and Migration in Florida Aceituno



Key: Persons Present ————
Deaths + outmigration ----------
Births + inmigration ----------

in or out of these villages.

Birth and death rates have been widely used in the health comparison of communities, regions and nations. Some vital statistics from the two villages for the years 1974 and 1975 are given in Table II.3.

Meteorology

Guatemala has a rather uniform rainy-dry seasonal cycle. The rainy season is May through October and the dry season is November through April. There are, however, monthly and daily fluctuations within the monthly seasonal cycles. Rainfall was an interesting variable because other investigators have suggested that morbidity, particularly diarrheal disease, is seasonally related. Rainfall data for the years 1972-1975 is shown in Tables II.4 and II.5.

TABLE II.4

Amount of Rainfall (Millimeters)

	Guanagazapa				Florida Aceituno			
Month	1972	1973	1974	1975	1972	1973	1974	1975
Jan	0	0	20	0	0	0	20	10
Feb	0	0	0	0	20	0	10	10
Mar	10	0	90	0	30	0	100	0
Apr	80	150	50	90	180	110	10	50
May	430	220	400	260	310	390	330	390
June	330	610	560	250	370	420	570	210
July	190	290	180	190	290	280	200	400
Aug	130	520	110	340	190	470	290	300
Sept	210	400	450	630	210	360	610	660
Oct	330	500	120	340	240	470	180	390
Nov	190	70	20	220	140	80	40	180
Dec	0	0	0	20	0	30	20	40
Total(in.)	75	108	79	92	78	103	94	104

TABLE II.3

Vital Statistics from Guanagazapa and Florida Aceituno

Compared to Countries in the Americas

Vital Statistic	Guanagazapa 1974	Guanagazapa 1975	Florida Aceituno 1974	Florida Aceituno 1975	Guatemala 1972	Mexico 1972	Panama 1972	United States 1972
Crude death rate	9.9	10.8	17.6	12.3	16	10	10	9.5
Crude birth rate	46.5	37.1	54.9	42.0	46	44	42	17.[illegible]
Infant Mortality rate	0.0*	97.6	60.0	24.4	89	64	43	21.0
Vital index	4700.0	3417.0	3125.0	3416.7	-	-	-	-

*The infant mortality rates in these villages are based on very few infant deaths. Infant deaths in Florida Aceituno were: 1973-2; 1974-3; 1975-1 and in Guanagazapa: 1973-3; 1974-0; 1975-4.

Key: Crude death rate = $\frac{\text{total deaths}}{\text{midperiod total population}} \times 1000$

Crude birth rate = $\frac{\text{total live births}}{\text{total population}} \times 1000$

Infant mortality rate = $\frac{\text{deaths of children} < 1 \text{ year of age}}{\text{total live births}} \times 1000$

Vital index = $\frac{\text{total live births}}{\text{total deaths}} \times 1000$

TABLE II.5

Average Number of Days with Rainfall, 1972-1975

(Rainfall Millimeters)

Month	Guanagazapa	Florida Aceituno
January	0	1
February	0	1
March	1	3
April	5	6
May	15	18
June	17	19
July	13	15
August	15	20
September	19	20
October	16	18
November	6	7
December	0	1

Village Economic Status

Economic studies in these two villages were initiated in April 1973 and terminated in September 1974. Four indicators (total hours worked, total energy expenditure, gross individual income, days of no economic activity) were chosen to provide a community economic profile. The studies were intended to determine the impact of changes in water usage and improved sanitation on the economic status of families in Guanagazapa. However, these studies were terminated on the recommendation of an external review committee.

Adult males in Guanagazapa were generally employed on coffee plantations and those from Florida Aceituno on sugar plantations. There was very little (15% or less) employment in non-agricultural occupations. The average number of hours worked per two week period during the harvesting season was 93 ($\pm$ 29) for Guanagazapa workers. The harvesting season varies

with the crop grown and the annual rainfall. The mean gross income per worker for a two week period (August 1973-September 1974) was slightly higher in Florida Aceituno ($17.42 ± 9.55) than in Guanagazapa ($12.81 ± 9.05). The gross income includes monetary income from agricultural and nonagricultural employment but excludes income from agricultural self-employment (sale of crops) and net income from property (real and financial).

The economic data, though limited in scope and based on a relatively small sample, indicated less unemployment, a higher gross income and more land ownership in Florida Aceituno than in Guanagazapa. The methodology report (Chapter II) provides further information on the study communities including detailed descriptions of the villages, ethnic origin of the villagers, occupational patterrs and literacy.

III. Morbidity

Morbidity data was collected in both villages during each month of the study although several months were missed. For instance, field work was not done in December because of the holiday patterns in Guatemala. A two-week recall method was used (see Methodology: Volume 1). Therefore, the data and analyses presented here cover only two weeks of each month and is subject to all the limitations of recall information, including problems of time and of the respondents knowledge of the family health status.

Total morbidity was not significantly different in the two villages (Tables III.1 and III.2). What appears to be a higher total morbidity and diarrheal morbidity in the first six months of the study (season 1) can only be interpreted as an observer effect due to the newness of the experience for the villagers.

TABLE III.1

Total Morbidity by Season

	Total Morbidity/Fortnight/1000 Population*						
	Season**						
Village	1R	2D	3R	4D	5R	6D	7R
Guanagazapa	153	123	186	133	130	107	124
Florida Aceituno	170	134	144	126	163	145	155

*Incidence computed on two-weeks experience in each month. The true incidence will be higher than this for an entire month.
**R: rainy season (May-October); D: dry season (November-April).

Diarrheal and respiratory illness, skin infections and infectious diseases were selected for detailed analysis. Respiratory illness and diarrhea accounted for 67% of the total morbidity in Florida Aceituno

and 68% in Guanagazapa. Skin infections and respiratory disease were seen more frequently in Guanagazapa while malnutrition and chronic diseases occurred more often in Florida Aceituno.

TABLE III.2

Total Illness by Disease Category

Total Morbidity (May 1973-August 1976)				
Disease Category	Florida Aceituno	Percent of Total	Guanagazapa	Percent of Total
Eruptive and viral	72	1.5	161	3.1
Trauma	132	2.7	119	1.8
Skin infections	181	3.7	439	8.6
Respiratory	1633	33.5	2096	40.8
Anemia	92	1.9	77	1.5
Digestive(1)	139	2.8	173	3.4
Malnutrition	390	8.0	188	3.7
Infectious	572	11.7	458	8.9
Chronic and subchronic	23	0.5	4	0.1
Diarrhea	1647	33.7	1414	27.6
Total	4881	100.0	5129	100.0
Person Months	32831		37172	

(1) Excluding diarrhea.

There was significant monthly variation in the illnesses being monitored (Tables III.3 and III.4). For a single individual, it can not be assumed that the two week recall each month represents exactly 50% of the incidents of illness during that month. The "true number of illnesses" in any given month for an individual may be less than or more than twice the incidence recorded by the field staff. Doubling

the average community rate reported should be reasonably close to the "true rate" of illness.

TABLE III.3

Mean Seasonal Morbidity Rates for Selected Diseases in Guanagazapa

Time Interval	Mean Morbidity Rate/1000 Population (1)			
	Diarrhea	Respiratory	Skin	Infectious (2)
Season 1 (R)(3)	82.4	17.2	24.0	3.0
2 (D)	39.7	53.8	12.5	3.5
3 (R)	33.3	109.4	12.4	16.6
4 (D)	23.3	69.6	7.7	10.0
5 (R)	28.2	34.4	8.6	37.1
6 (D)	27.8	53.9	10.1	1.6
7 (R)	39.5	52.7	9.1	4.3
Total (Std. Error)	38.3(1.00)	56.7(1.20)	11.9(0.56)	12.4(0.58)

(1) Rates computed on two weeks experience in each month.

(2) Infectious diseases: conjunctivitis, ótitis.

(3) Rainy season (May-October); Dry season (November-April).

TABLE III.4

Mean Seasonal Morbidity Rates for Selected Diseases in Florida Aceituno

Time Interval	Mean Morbidity Rate/1000 Population			
	Diarrhea	Respiratory	Skin	Infectious
Season 1 (R)	98.5	12.2	9.6	26.4
2 (D)	59.2	38.0	4.6	7.7
3 (R)	40.5	68.5	2.3	11.9
4 (D)	39.4	55.5	4.6	13.4
5 (R)	38.2	55.3	6.2	32.4
6 (D)	40.6	49.3	5.1	11.9
7 (R)	47.1	62.0	6.8	12.9
Total (Std. Error)	50.4(1.21)	49.9(1.20)	5.5(0.41)	17.5(0.72)

There was an apparent epidemic of respiratory disease in Guanagazapa during the rainy season of May to October 1974 (Season 3). The etiology is not known, nor were there any attempts to determine etiological agents by laboratory analysis.

Diarrhea

No cases of typhoid or cholera was seen in either of the villages. Salmonella and/or shigella cultures were done on a sample of the population and were infrequently isolated from individuals with diarrhea. The laboratory tests were not intended to confirm a diagnosis and the etiology of most diarrheas was not established. No laboratory tests for viral isolations were attempted.

Children in the 1-2 year age group had a significantly higher diarrheal morbidity rate than other age groups in these populations (Table III.5). This age group represents the period when children

have been weaned and are beginning to walk extensively. They are likely to have the highest fecal-oral exposure. Children seven years and under accounted for 83% of all the diarrhea reported in the total population.

TABLE III.5

Diarrheal Morbidity Rate by Age and Sex

	Mean Morbidity Rate/1000 Population[1]					
Age Group (years)	Guanagazapa Male	Guanagazapa Female	Florida Aceituno Male	Florida Aceituno Female	Total	Std Error
0-1	140.9	99.5	122.4	96.0	113.5	5.68
1-2	204.8	208.8	218.3	225.4	214.4	7.86
2-7	69.9	74.3	121.0	98.9	89.1	2.64
7-15	17.8	26.3	35.0	40.5	28.3	1.39
15-30	9.5	13.4	11.3	22.6	13.9	0.88
30-45	15.1	12.8	14.0	30.0	17.3	1.31
45-99	19.3	33.0	18.1	34.2	25.4	1.55

(1) Rates computed on two weeks experience in each of 35 months.

However, adult diarrhea was probably underestimated. Mild diarrheal episodes in adults were not considered as disease events by the villagers and often were not reported. Adults who elected to come to the health post with complaints of diarrhea usually had clinical dysentery with six to eight bowel movements each twenty-four hours.

Diarrheal disease was not related to sex except in the one year and under age group where the males had a significantly higher rate than females (Table III.5). Whether this represents a cultural difference in the maternal management of infant males and females is not known. There appears to be a higher incidence of diarrhea in adult females

but this is probably an artifact due to the fuller knowledge of the informant (usually an adult female) about diarrheal episodes in the female family members than in the adult male, who left home each day to work in the fields.

Diarrheal morbidity was not seasonal in these populations. Diarrhea did not increase in the rainy season. Even when adjusted for age and sex, diarrhea was not significantly higher in the rainy season (Tables III.6 and III.7). However, when all the reference factors, including

Table III.6

Diarrheal Morbidity Rate by Age and Season

Age Category	1R	2D	3R	4D	5R	6D	7R
			Florida Aceituno				
			Morbidity Rate/1000 Population Seasons (thirty-five months)				
0-1	169	92	85	105	93	120	113
1-7	183	152	111	99	98	116	135
7+	55	31	19	18	18	14	19
			Guanagazapa				
0-1	151	136	96	94	122	139	98
1-7	190	104	93	51	76	69	103
7+	49	15	13	12	10	10	19

sanitation, were controlled for in the analysis, both infectious diseases and diarrhea rates were statistically higher ($p < .05$) in both villages in the rainy season (see page 79, text and Figures IV.12 and IV.13).

TABLE III.7

Diarrheal Morbidity Rate by Village, Sex and Season

	Morbidity Rate/1000 Population Seasons (thirty-five months)						
Category	1R	2D	3R	4D	5R	6D	7R
Florida	98	59	40	39	38	41	47
Guanagazapa	82	40	33	23	28	28	39
Males	82	45	33	31	32	30	40
Females	98	53	41	31	34	38	47

Diarrheal morbidity varied with family size in both villages. The rate increased with family size up to a family size of five or more persons (Table III.8 and III.9). This relationship was not unexpected since larger families have more persons at risk and in close contact with an index case. However, an analysis of diarrheal morbidity rates in families with and without infants (≤ two years), did not show a higher rate in adults in those families with children. This seems to indicate that infants (≤ two years) were not the usual source of diarrhea for adults in a family.

TABLE III.8

Diarrheal Morbidity by Family Size and Village

	Morbidity Rate/1000 Population Number of Persons in Family					
Village	1	2	3	4	5	5+
Florida Aceituno	26	21	44	54	55	49
Guanagazapa	12	25	35	38	42	35

TABLE III.9

Diarrheal Morbidity for Families of Five or More Persons by Season and Village

	Mean Morbidity Rate/1000 Population						
Village	1R	2D	3R	4D	5R	6D	7R
Florida Aceituno	111	61	39	36	37	41	53
Guanagazapa	91	44	35	17	28	27	42

Village Morbidity

Detailed morbidity data for both study villages is presented in the Appendix (page vii). This data covers 32,831 person-months of morbidity experience in Florida Aceituno and 37,172 person-months in Guanagazapa.

Respiratory illness was the leading cuase of morbidity. This was followed by diarrheal disease, with childhood diseases (measles, chickenpox) a distant third. The morbidity profile for both villages was not unusual since it appeared to reflect the experience of a free-living population with poor sanitation and low family incomes.

IV. Water and Sanitation

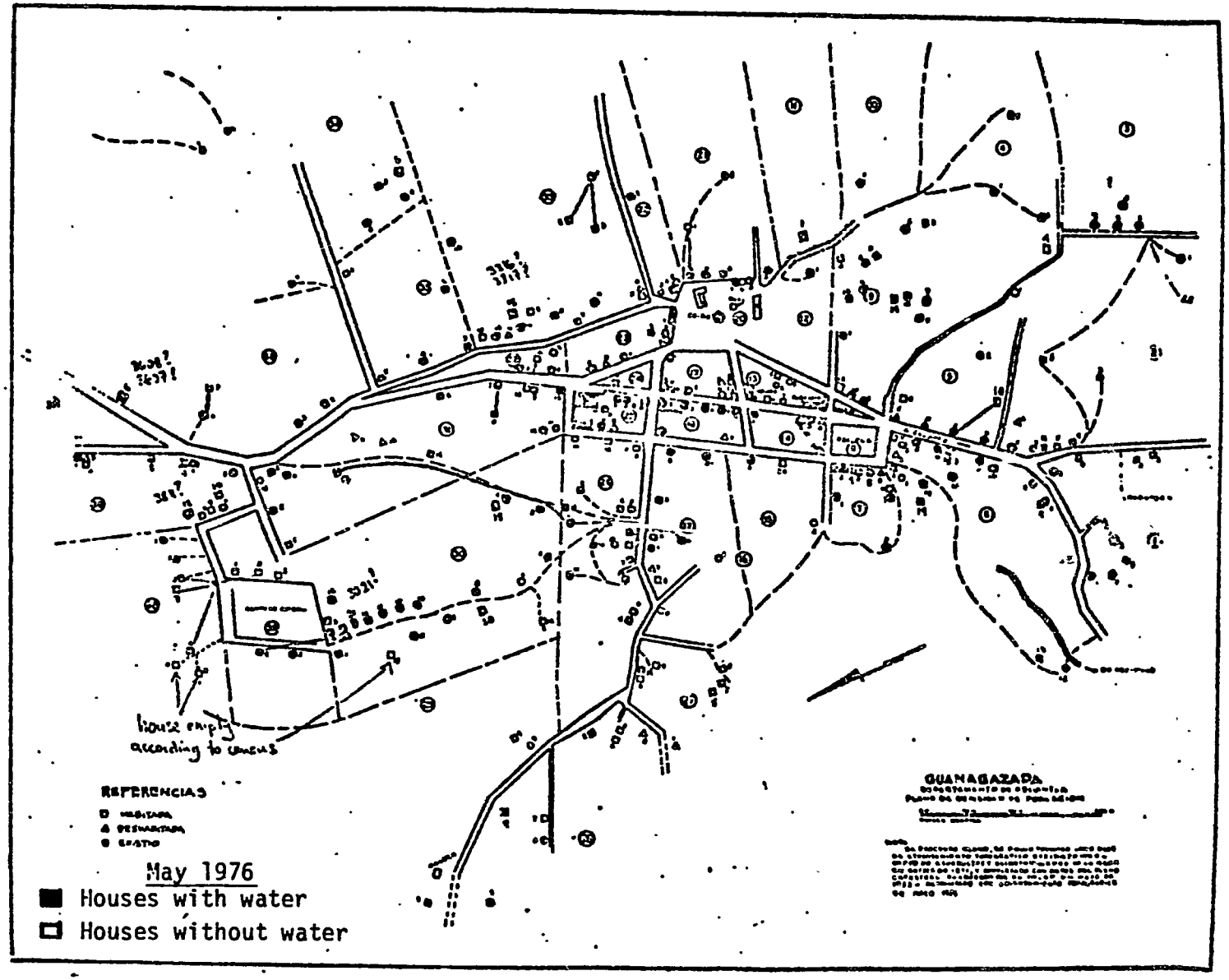
A water supply system was constructed in Guanagazapa (experimental village) by the Ministry of Public Works. Part of the cost was borne by the project. The construction started in August 1972 and was completed in September 1973. The disinfection equipment was installed after the distribution system was on-stream and chlorination began in January 1974. The approximate total cost of construction of the system was $67,240 or $410 per connection (including a faucet and water meter for each connection). This estimate is approximate because it was not possible to compute the exact cost since some of the costs were absorbed by the Ministry of Public Works and some of the later connections were made by individual homeowners.

Water was piped into the yard of 103 houses during the original construction. By May 1976, an additional 61 connections had been made and at the end of the study 164 houses (65%) were using the new water system. In addition, 13 houses in the center of the village were using a small water system which existed prior to the installation of the new system. The water supplied by the old system was and still is not chlorinated (Figure IV.1).

After construction, the operation of the system was taken over by the National Institute of Municipal Development (INFOM). The community provides a municipal employee who is responsible for bill collection, system repairs, meter reading and adjusting and measuring residual chlorine levels. Each family was charged $10 for a connection to the system and $0.65 per month for quantities of water up to 30,000 liters (1000 liters/day). At the maximum consumption rate (30,000 liters),

FIGURE IV.1

Water Distribution System In Guanagazapa



this is equivalent to 12¢ per 1000 gallons. The usual water rate in the United States is 60-80¢/1000 gallons, however, $0.65 represents 3% of the mean monthly income for workers in Guanagazapa. The mean water consumption in Guanagazapa at the end of the study (July 1976) was 68.4 liters per person per day (Table IV.8). Thus, a family of four would use 273.6 liters per day or 8345 liters per month. At this usage level, the cost of water would be 30¢ per 1000 gallons for this family.

Shallow wells were the principal water source in Florida Aceituno (Table IV.1). These wells were generally of the dug variety with no casing. The parapet was usually an old automobile tire and no covers were used. Water was drawn manually by bucket.

TABLE IV.1

Water Sources in Florida Aceituno 1975

Source	Number of Families	Percent of Families
Family well	98	48
Neighbor's well	47	23
River	19	9
Unknown	40	20
Totals	204	100

Nine percent of the families in Florida Aceituno carried water from the river which ran beside the village. The river was also used for clothes washing and bathing.

Protection of Water Quality

The water distribution system in Guanagazapa was continuously chlorinated and this was reflected in the high bacteriological quality

of this water. However, each time a sample was collected for bacteriological analysis, the condition of the faucet was observed and the data recorded. Nineteen percent of the faucets were not properly maintained, thirty-one percent were leaking and thirty-four percent were dirty (encrusted with foreign matter). These conditions did not appear to affect the high quality of the water being delivered to the consumer (Table IV.5).

An inspection of individual dug wells in Florida Aceituno (control village) was also made when samples were collected. These wells were poorly constructed and protected. Sixty percent were without any type of cover to protect against dirt, insects or other contamination, seventy percent were not cased and most were curbed with an old automobile tire.

Domestic water containers in Guanagazapa were not adequately protected to maintain the high quality of the water provided in the distribution system (Table IV.2). Sixty percent of the containers

TABLE IV.2

Protection and Water Quality in Household Containers in Guanagazapa by Season

Percent of Total Examined

Season	Container Dirty	Container Uncovered	Coliform Bacteria Present
1R	53%	63%	34%
2D	61	86	52
3R	58	84	53
4D	71	80	40
5R	90	72	28
6D	71	50	29
7R	70	60	49

examined were dirty, twenty-four percent were in poor condition and only thirty-three percent were covered. These conditions did not improve over the course of the study (Table IV.2). Water containers in Florida Aceituno were in worse condition. Seventy-seven percent were dirty and only twenty-nine percent were kept covered.

Chemical Water Quality

Fifteen water samples were collected from each village during the study period (1973-75) for chemical analysis. Potable water quality met all the criteria, except turbidity, of WHO's International Standards for Drinking Water (1958) and the United States National Interim Primary Drinking Water Standards of 1975 (Table IV.3). Drinking water in both villages was "soft", contained few total solids and had a neutral pH. The well water in Florida Aceituno was, on the average, more turbid than is desirable.

Bacteriological Water Quality

Bacteriological water quality in both villages was determined using a field test (Colitester*) and standard laboratory procedure (Standard Methods for the Examination of Water and Wastewater, 12th edition, APHA-AWWA-WPCF). Source water quality (wells in Florida Aceituno, distribution system in Guanagazapa) and final use water quality (domestic containers in both villages) were measured.

1. Standard Laboratory Analysis

Twenty-one water samples were collected randomly among longitudinal sample families in each village during the study period and analyzed for total and fecal coliform bacteria (Table IV.4).

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*Millipore Corporation

TABLE IV.3

Chemical and Physical Water Quality

Mean Values

Constituent (ppm)	Florida Aceituno	Guanagazapa	WHO*	United States**
Color	3±2	4±5	5 units	15 units
Turbidity	13±28	2±4	5 units	5 units
Total solids	165±47	190±43	500	500
Total hardness	69±20	76±28	-	-
Carbonate alkalinity	4±5	10±14	-	-
Bicarbonate alkalinity	56±18	87±43	-	-
Chlorides (Cl)	9±5	3±2	200	250
Nitrates (NO_3)	2±4	0.4±0.5	50-100	45
Sulfates (SO_4	14±4	15±8	200	250
Copper	.03±0.1	0	1.0	1.0
Iron	.07±0.1	.07±0.1	0.3	0.3
Manganese	.01±.03	0	0.1	0.05
Lead	0	0	0.1	0.05
Total alkalinity	56±16	95±41	-	-
Fluorides	.09±.01	.03±.03	1.0-1.5	1.4-2.4
pH	6.9±0.6	7.3±0.8	7.0-8.5	-

*Permissible standards
**National Interim Primary Drinking Water Standards 1975

TABLE IV.4

Bacteriological Water Quality
(Laboratory Analysis)

Mean Number of Bacteria/100 ml

Village and Criteria	Well	Faucet	Domestic Container
Guanagazapa			
MPN (total coliform)	-	611	423
Range (total coliform)	-	0 - 5420	0 - 1609
Percent satisfactory	-	42%	25%
Fecal coliform	-	484	393
Range (fecal coliform)	-	0 - 5420	0 - 2400
Percent satisfactory		75%	50%
Florida Aceituno			
MPN (total coliform)	1840	-	2767
Range (total coliform)	23 - 2780	-	1300 - 9180
Percent satisfactory	0%		0%
Fecal coliform	1205	-	1304
Range (fecal coliform)	5 - 2400	-	79 - 2400
Percent satisfactory	0%		0%

The laboratory analysis of these samples was used as an external quality control for the field test method. Duplicate samples analyzed by both methods indicated that the results were in agreement for 11 samples, questionable for 5 samples and did not agree in 2 samples.

2 Colitester Analysis

The Coli-Count Water Tester (Millipore Corporation, Bedford, Massachusetts) provides a simple, rapid, field method for detecting the presence or absence of coliform bacteria in water.

a. Guanagazapa Water Distribution System. Six hundred and ninety-eight samples were tested. Ninety-seven percent of these samples were free of coliform bacteria (satisfactory quality). The results are shown in Table IV.5. These results demonstrate the high quality of water delivered to the homes connected to the distribution system.

TABLE IV.5

Bacteriological Water Quality in Guanagazapa

Colitester Analysis	Distribution System (faucet)	Water Container
Number of samples	698	753
Percent satisfactory (no coliforms)	97.3%	65.2%
Samples with 1≤5 coliform/100 ml	15	142
Samples with >5 coliform/100 ml	4	120

b. Guanagazapa Domestic Water Containers. The use of domestic water containers decreased in Guanagazapa over the period of the study. It became more convenient to go directly to the faucet in the yard and collect only the amount of water which was needed for a specific use.

Seven hundred and fifty-three samples were analyzed and sixty-five percent contained no coliform bacteria (Table IV.5). When water containers were used - the final use water, i.e., stored in a container in the home - was of a lower bacteriological quality than that in the distribution system. This contamination could have resulted from using a dirty container, from the air or from human sources (Table IV.2). One objective of the sanitary education program was to improve final use water quality (Chapter V).

c. Florida Aceituno Well Water. Five hundred and five samples were tested. Forty-eight percent of these samples were free of coliform bacteria (Table IV.6). Source water quality in Florida Aceituno was generally unsatisfactory. This correlates well with the poor construction and protection of individual wells in this village.

TABLE IV.6

Bacteriological Water Quality in Florida Aceituno

Colitester Analysis	Well	Water Container
Number of samples	505	875
Percent satisfactory (no coliforms)	48.3%	40.6%
Samples with 1≤5 coliform/100 ml	133	206
Samples with>5 coliform/100 ml	97	314

d. Florida Aceituno Domestic Water Containers. Eight hundred and seventy-five samples were analyzed and fifty-nine percent were positive for coliform bacteria (Table IV.6). Even though only 52% of the well samples contained coliform bacteria, 59% of the samples from domestic containers were contaminated. This substantiates the

data from Guanagazapa that the containers were a source of contamination for final use water quality.

Water Consumption

Families in Guanagazapa used, on the average, two and one-half times as much water per person (68.4 liters/person/day) as those in Florida Aceituno (26.0 liters/person/day) after the installation of the water system (Table IV.8). Water consumption in Guanagazapa increased in the first few months after the new distribution system was onstream (Table IV.7) but then leveled off between 70-80 liters per person per day and remained relatively constant, on the average, for the remainder of the study. All of this increase does not represent a true doubling of water use. Some of the increase was due to transference of water

TABLE IV.7

Mean Water Consumption in Guanagazapa
(Six Months Experience with Distribution System)

Month	Water Consumption liters/person/day*
October 1973	40.3
November 1973	49.2
December 1973	48.3
January 1974	70.4
February 1974	71.2
March 1974	68.8
July 1976	64.5

*Sample includes all families using distribution system. Consumption computed from water meters. Consumption data exceeding 200 liters/person/day was considered spurious and excluded in the computation of means. (see text).

TABLE IV.8

Mean Water Consumption in Guanagazapa and Florida Aceituno by Quarter

Quarter	Mean Water Consumption liters/person/day* Florida Aceituno	Guanagazapa
1 (5/73)	-	-
2	-	40.3
3	24.6	56.0
4	21.8	70.2
5	31.3	63.8
6	18.0	61.9
7	33.6	79.0
8	27.1	82.0
9	25.2	70.2
10	22.1	70.0
11	25.5	80.0
12	32.2	74.0
13 (9/76)	24.6	73.5
Mean	26.0	68.4

*Florida Aceituno: consumption computed on longitudinal families only, recall method used to compute usage, and usage above 200 l/p/d excluded (see text).

Guanagazapa: consumption collected on all families using the distribution system, usage computed from water meters, and usage above 200 l/p/d excluded (see text).

se activities from the river or the community "pila" to the home. However, this usage pattern does demonstrate that, when a high quality chlorinated water is available, it will be used for most household purposes. (Figures IV.2 and IV.3) Family consumption which exceeded 200 liters/person/day was not included in the computation of means shown in Tables IV.7 and IV.8. This rate was so much above the mean that it was assumed that leakage had occurred or the water was being used for agricultural or other non-household purposes.

The amount of water used, on the average, in Florida Aceituno (control village) was significantly less than that in Guanagazapa (Table IV.8). However, the data for this community was obtained by recall and represents only the water which was drawn from the well and does not include the use of the river for laundry and bathing purposes. The river in Florida Aceituno was in close proximity to the village which was not the case in Guanagazapa.

Water Uses

Each month longitudinal families in both villages were asked for what purposes they used water in the home (Table IV.9). In both villages, most families brought water to the house (faucet in the yard is assumed to mean water in the house) for personal hygiene purposes, food preparation and the washing of eating and cooking utensils.

In Florida Aceituno, less than one-third of the families did their laundry and less than one-fifth bathed at home. Eighty percent of the families in Guanagazapa washed clothes and bathed at home. These data were collected starting in November 1973, thus the water use practices prior to the installation of the water distribution system is not known. Twenty percent, on the average, of the families observed in Guanagazapa

FIGURE IV.2

Mean Water Consumption by Family in Guanagazapa

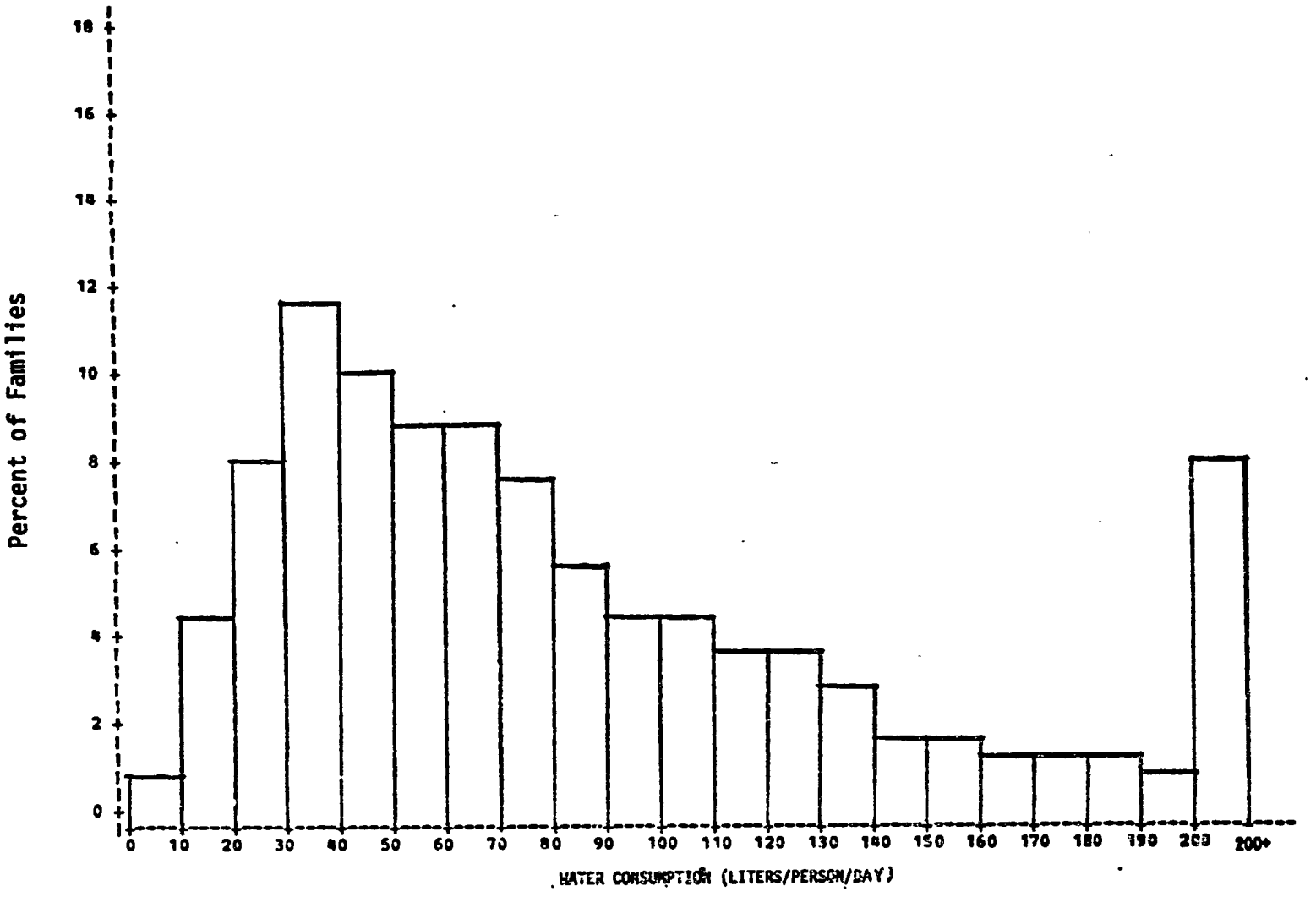


FIGURE IV.3

Mean Water Consumption by Family in Florida Aceituno

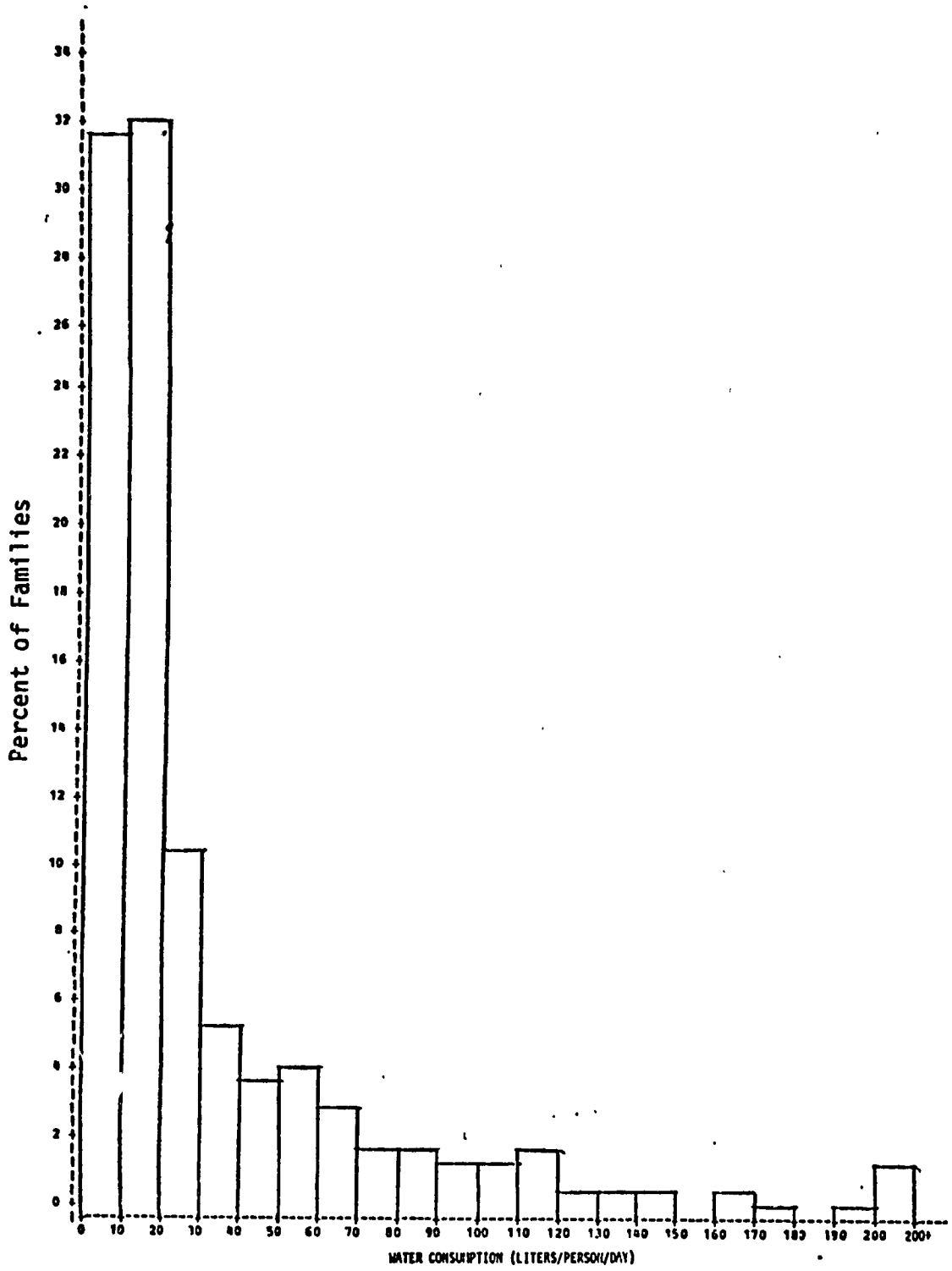


TABLE IV.9

Home Water Uses in Guanagazapa and Florida Aceituno by Season

Water Use	Percent of Families Seasons						
	1R*	2D	3R	4D	5R	6D	7R
	Florida Aceituno						
Personal hygiene	-	100	92	100	98	98	100
Food preparation	-	100	100	100	99	99	100
Utensil washing	-	95	96	96	92	96	96
Laundry	-	28	23	33	31	30	19
Bathing	-	26	16	16	18	10	12
	Guanagazapa						
Personal hygiene	-	100	100	100	100	100	97
Food preparation	-	100	100	99	100	100	100
Utensil washing	-	100	100	99	100	99	97
Laundry	-	75	83	83	80	91	84
Bathing	-	75	79	80	80	91	79

*Information not available.

continued to wash clothes and bath away from home even though water was available in their yards and the cost per month was the same whether they used 1 or 30,000 liters.

More detailed data on the protection of water sources, protection of water quality and water consumption are shown in Appendix IV (page xxix).

Housing Quality and Household Sanitation

Forty-nine randomly selected houses in Guanagazapa were thoroughly inspected in August and September 1972 at the beginning of the study. These inspections were used to document housing quality including construction, number and arrangement of rooms, housekeeping, presence of domestic animals, and protection of food and water. Based on observations made during the study period, these 49 homes were representative of the village as a whole.

Only two houses in the sample formed a duplex, most were single unattached structures. House size ranged from one to eight rooms (Table IV.10)

TABLE IV.10

Number of Rooms in Guanagazapa Houses

Rooms	Number Houses	Percent
1	15	31
2	19	39
3	7	14
4	6	12
5	1	2
6	0	0
7	0	0
8	1	2
Total	49	100

with 31% (15) single room dwellings in which all eating, sleeping and leisure activities took place in that one room. The cooking hearth (usually an open fire) was located outside at many of these homes. In houses with two or more rooms, one of the rooms was usually a kitchen-dining area. Eighty-four percent of the houses contained three rooms or less.

The quality and permanence of construction materials was generally a function of house size. Larger houses usually were more permanent and substantial. For example, the one eight room house in our sample was constructed with a metal roof, adobe walls and a cement floor in the kitchen. However, there were earthen floors in the other rooms. Sixty-one percent of all kitchen floors and eighty percent of the other floors in our sample were earth (Table IV.11). Only 9 houses had cement floors throughout the structure.

Metal was the most common roofing material. Even though it was more expensive than cane or bamboo, it provided better protection during the rainy season.

Seven families (14%) had provided compounds to restrain domestic animals. Animals were observed inside or in the yard of 90% of the homes inspected. Twenty-nine percent of the families had chickens, twenty-three percent had dogs, fourteen percent had pigs, twelve percent had cats, six percent had ducks, four percent had parrots, and two percent had rabbits. These animals were usually allowed to wander freely in and out of the house.

Annual surveys were made of these houses. Only minor structural improvements were made during the course of the study (August 1972 - August 1976). The only structural modifications advocated by the project

TABLE IV.11

Housing Construction in Guanagazapa

Number of Houses

Component	Adobe	Metal	Cane-Bamboo	Straw	Tile	Cement	Earth	Wood Boards	None Present
				Living - bedroom(s)					
Roof		44		3	2				
Walls	8		32			3		6	
Floor					4	6	39		
				Kitchen					
Roof		23		7	3			16	
Walls	4		24			1		4	16
Floor					2	3	30	14	

were the installation of a door barrier to keep animals out of the kitchen and the construction of a latrine.

Home Sanitation

Regular surveys were made throughout the study (see Methodology) to determine the sanitary conditions of houses included in the longitudinal sample in both villages. Sixteen criteria were chosen as being representative of sanitary behavior in Guanagazapa and Florida Aceituno (Table IV.12). These results indicate that garbage and trash were poorly handled, domestic animals were frequently present in the kitchen, eating utensils were not stored to prevent contamination, and housekeeping was poorly done. Maintaining a clean home environment was extremely difficult because of dusty conditions in the dry season, continual mud in the rainy season, earth floors, and the loose construction of walls and roofs. Except for one criteria, cleanliness of clothing, home sanitation was superior in Guanagazapa.

Nine of the sixteen criteria were examined over time (by season) to detect improvement in sanitary behavior (Table IV.13). This methodology was also used to evaluate the impact of the health education program in Guanagazapa (see Chapter V). There appeared to be some improvement in: (1) the use of barriers to exclude animals from the kitchen; (2) the protection of cooked food; (3) the condition of the kitchen floor (absence of trash and garbage); and (4) the removal of trash and garbage from the yard. However, there was also improvement in the handling of trash and garbage in Florida Aceituno, both inside and outside the house, and no health education program was instituted in this village.

Additional data on housing quality and sanitation is presented in Appendix IV (Page lii).

TABLE IV.12

Home Sanitation in Study Villages

Mean Percentage of Sanisfactory Observations*

Environmental Variables	Guanagazapa	Florida Aceituno
Cleanliness of informants clothes**	76%	85%
Animals in the kitchen	46	42
Kitchen barrier present	8	1
Glasses and cups properly stored	19	10
Cooked food protected	94	94
Fecal material on kitchen floor	67	52
Flies seen on food	66	61
Garbage on kitchen floor	62	42
Eating plates protected from animals	96	95
Garbage and trash burned	1	3
Garbage in the yard	47	41
Latrine clean	61	50
Yard recently swept	50	40
Cleanliness of family's clothes**	72	83
Cleanliness of house**	50	45
Soap observed in house	61	36

*Mean percentages rounded to nearest whole integer.
**Met the norm for the village.

TABLE IV.13

Home Sanitation in Study Villages by Season

Selected Environmental Variables

Mean of Satisfactory Observations (Percent and Standard Error)*

Season	Animals Kitchen	Kitchen Barrier	Cooked Food Covered	Fecal Matter on Kitchen Floor	Flies on Food	Garbage on Kitchen Floor	Latrine Clean	Garbage in Yard	Yard Swept
Florida Aceituno									
1R**	57(3.5)	3(1.3)	48(3.9)	99(0.5)	99(0.6)	48(3.5)	56(7.1)	16(2.5)	47(3.4)
2D	34(3.6)	1(0.6)	61(4.1)	61(3.7)	95(1.7)	25(3.3)	40(7.4)	7(1.9)	51(3.8)
3R	31(3.3)	5(0.5)	58(3.7)	42(3.5)	73(3.2)	23(3.0)	74(6.9)	17(2.6)	38(3.4)
4D	28(4.8)	1(1.1)	58(5.6)	34(5.1)	61(5.4)	32(5.0)	45(11.4)	35(5.0)	36(5.0)
5R	30(2.9)	1(0.6)	41(3.2)	30(2.9)	41(3.2)	48(3.2)	66(6.1)	56(3.2)	34(3.0)
6D	40(5.6)	3(1.8)	57(6.0)	38(5.5)	60(5.9)	35(5.4)	65(10.2)	47(5.6)	35(5.4)
7R	59(3.8)	1(0.6)	59(4.0)	71(3.5)	63(3.8)	60(3.3)	48(7.6)	70(3.5)	55(3.8)
Guanagazapa									
1R	17(2.6)	2(1.0)	53(3.6)	71(3.2)	94(2.0)	20(2.8)	83(3.9)	11(2.2)	58(3.5)
2D	20(2.8)	1(0.7)	54(3.6)	42(3.4)	59(4.3)	22(2.9)	69(5.0)	19(2.7)	40(3.4)
3R	39(3.5)	2(0.9)	48(3.8)	60(3.5)	80(3.5)	23(3.0)	35(6.5)	29(3.2)	30(3.2)
4D	41(4.8)	1(1.0)	74(4.6)	70(4.4)	65(5.2)	50(4.9)	47(7.1)	57(4.8)	56(4.8)
5R	54(3.3)	17(2.5)	76(2.9)	81(2.6)	47(3.3)	35(3.1)	58(5.1)	61(3.2)	60(3.2)
6D	53(5.8)	24(4.9)	81(4.7)	70(5.3)	66(5.6)	43(5.7)	86(5.5)	55(5.7)	55(5.7)
7R	46(4.0)	29(3.5)	81(3.2)	62(3.9)	79(3.2)	62(3.9)	67(4.4)	68(3.7)	57(3.9)

*Mean rounded to nearest whole integer and standard error to one decimal place.
**R-rainy; D-dry.

Crowding In the Home

Some investigators have suggested that crowding in the home, institution or military barracks can contribute to morbidity.

The number of persons occupying bedrooms and total rooms in Guanagazapa was consistently higher (>1.0 persons/bedroom, and 1.0 persons/room) than in Florida Aceituno (Table IV.14). The mean and standard deviation of respiratory illness and diarrheal disease rates were plotted against crowding in bedrooms and in total rooms for both villages (Figures IV.4 through IV.11). Morbidity rates did not increase with either more persons per bedroom or more persons per room.

Additional data on crowding and morbidity is shown in Appendix IV (page liii).

Data Analyses For Morbidity-Sanitation-Water Associations

The combined census, morbidity, and sanitation data have been examined quite extensively by general linear and categorical models in an attempt to reveal any significant relationships between any of four types of morbidity and any of the study's measures of household sanitary quality or changes in sanitary quality. All of the analyses were adjusted for known "noise factors" such as month-to-month variability or seasonal differences. The analyses also included adjustments for, or took account of, factors such as age, sex, size of family and village, which are believed to influence morbidity. The results were adjusted for these factors so that the effects of sanitation could be estimated and tested "clearly", free of the possible effects of other characteristics, which might also affect morbidity. Four classes of morbidity were examined exhaustively: skin infections, infectious diseases, respiratory diseases and diarrhea. The sanitary measurements, which were examined, came from three survey instruments (see Methodology): Monthly Sanitation Survey (Form 32), Water Consumption and Usage (Form 37) and Water

TABLE IV.14

Household Crowding in Study Villages by Season

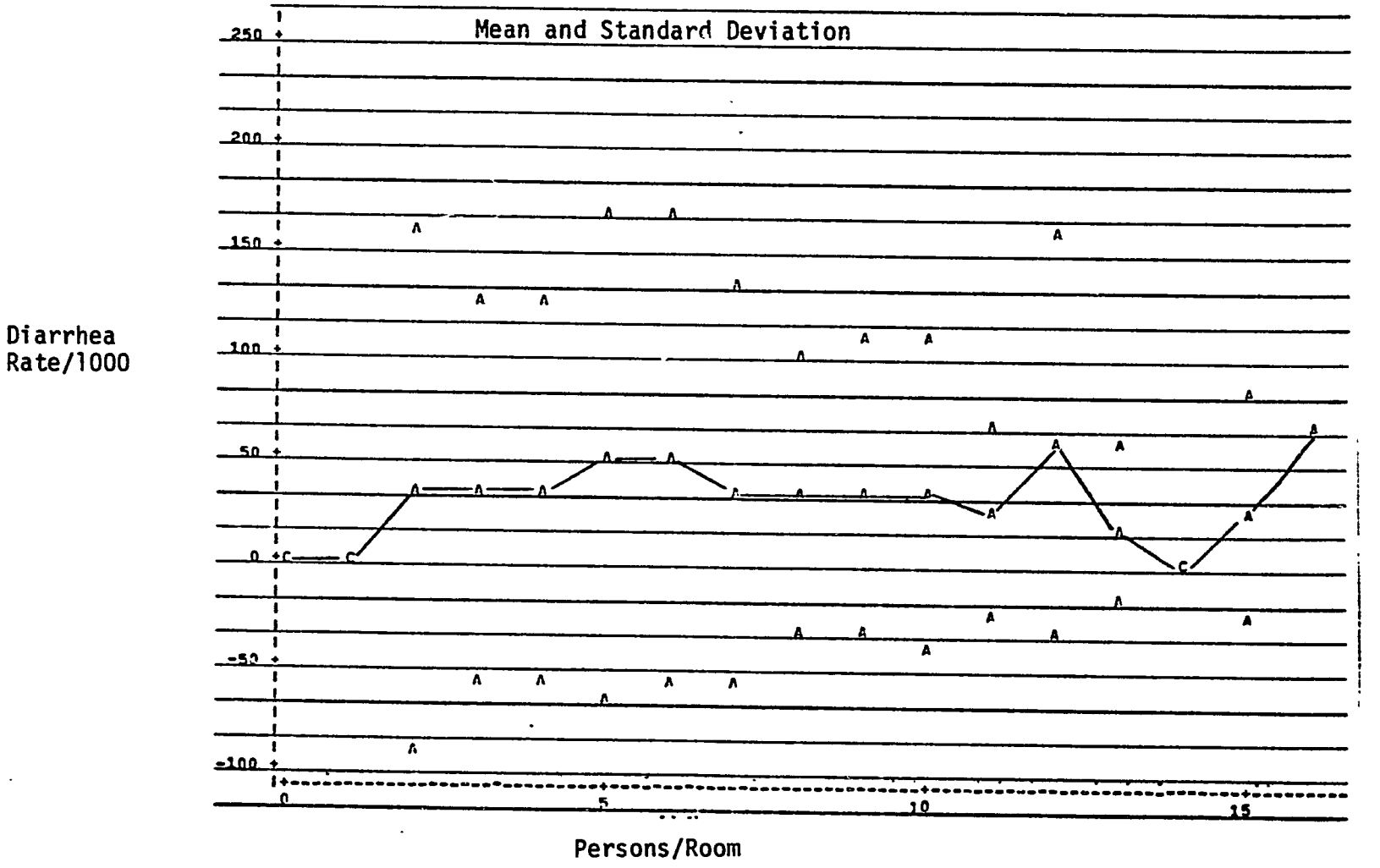
Mean of Observations

Season	Persons/Bedroom		Persons/Room	
	Guanagazapa	Florida Aceituno	Guanagazapa	Florida Aceituno
1R*	5.4	4.1	5.1	4.0
2D	4.9	4.0	4.7	3.8
3R	5.2	4.3	5.1	4.2
4D	5.4	4.6	5.3	4.5
5R	5.6	4.5	5.5	4.4
6D	5.7	4.4	5.2	4.3
7R	5.8	4.4	5.4	4.3

*R-rainy; D-dry.

FIGURE IV.4

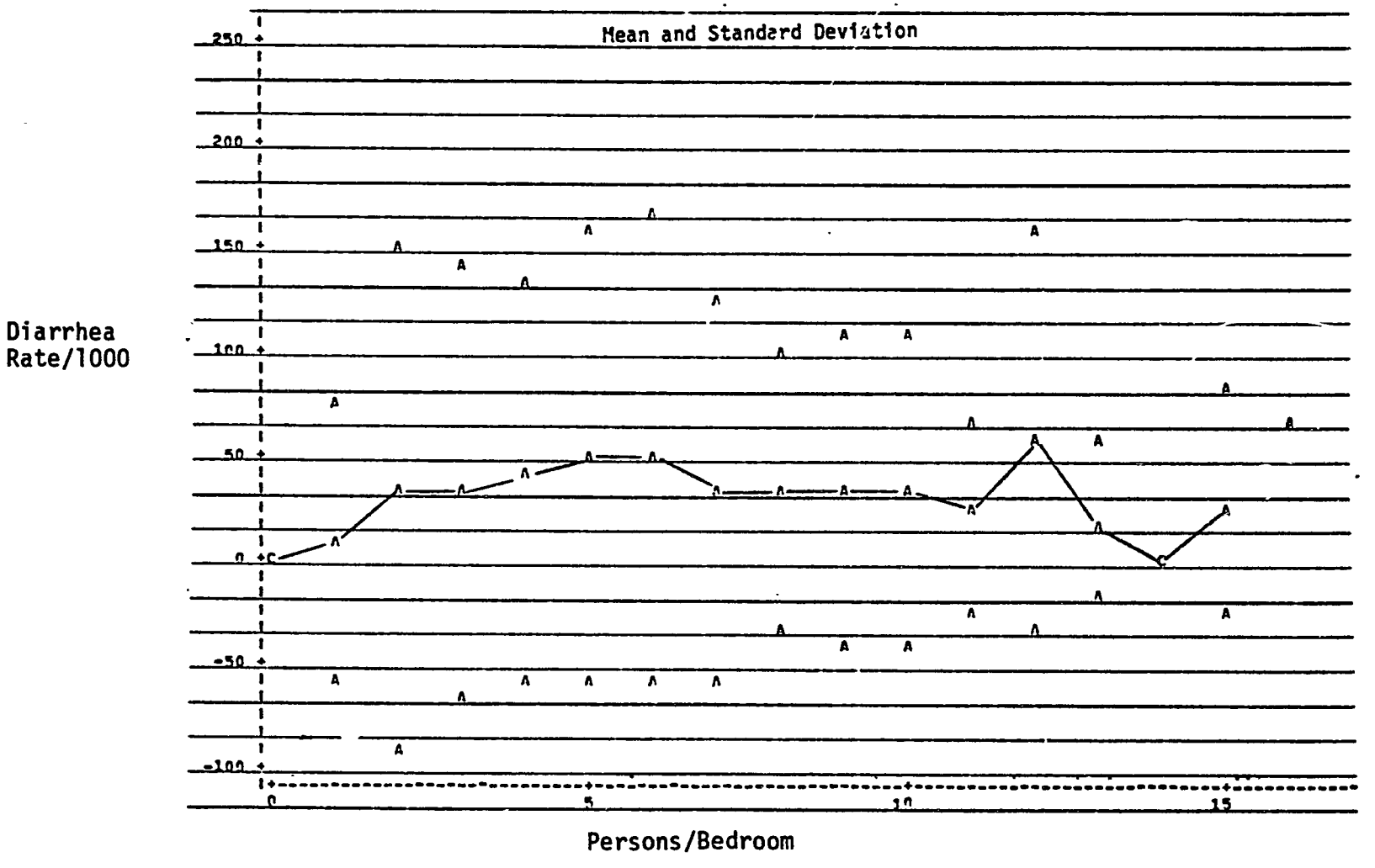
Diarrheal Morbidity Rate Versus Total Room Crowding Index
(Guanagazapa)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded to nearest whole integer.

FIGURE IV.5

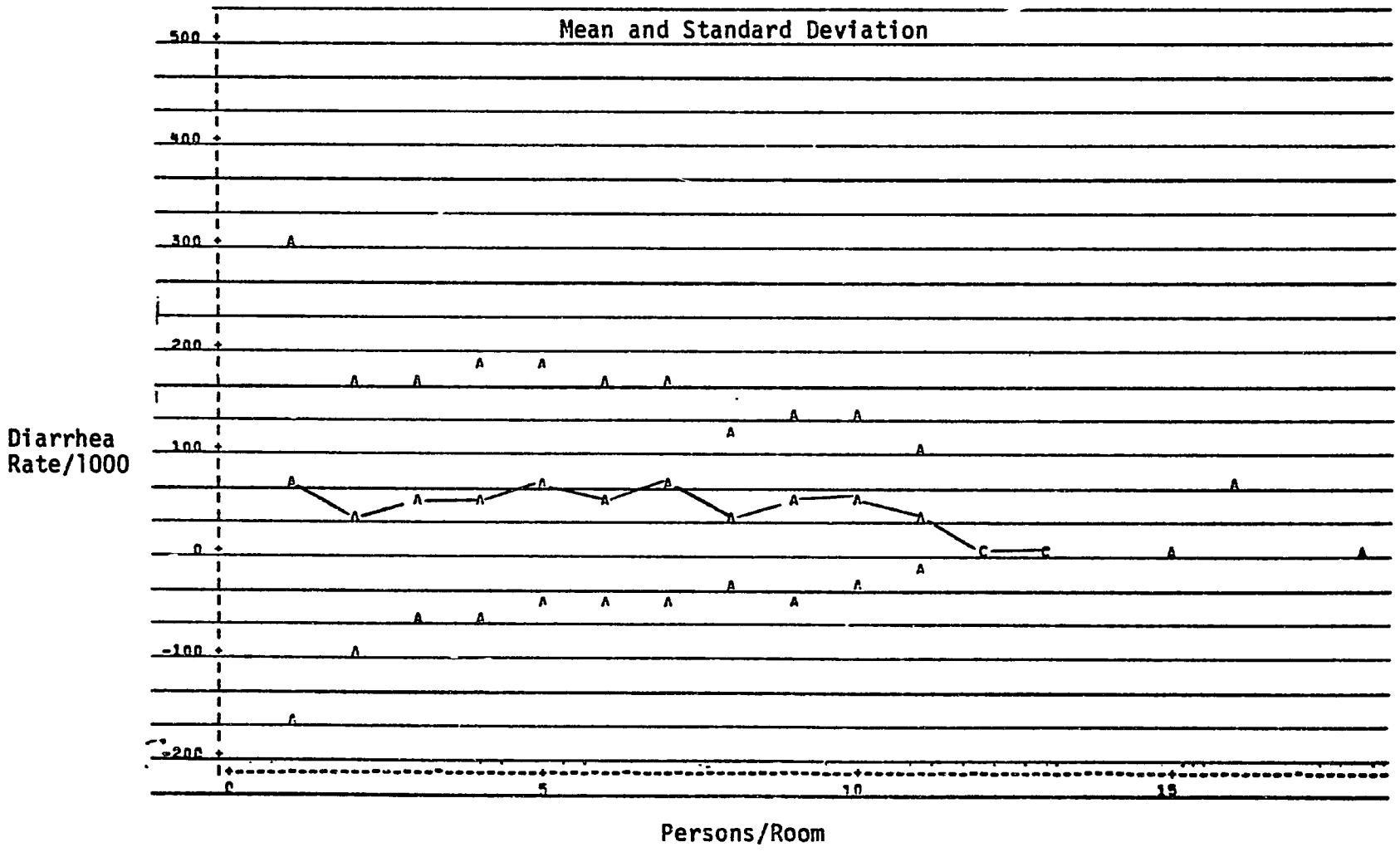
Diarrheal Morbidity Rate Versus Bedroom Crowding Index
(Guanagazapa)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/bedroom: rounded to nearest whole integer.

FIGURE IV.6

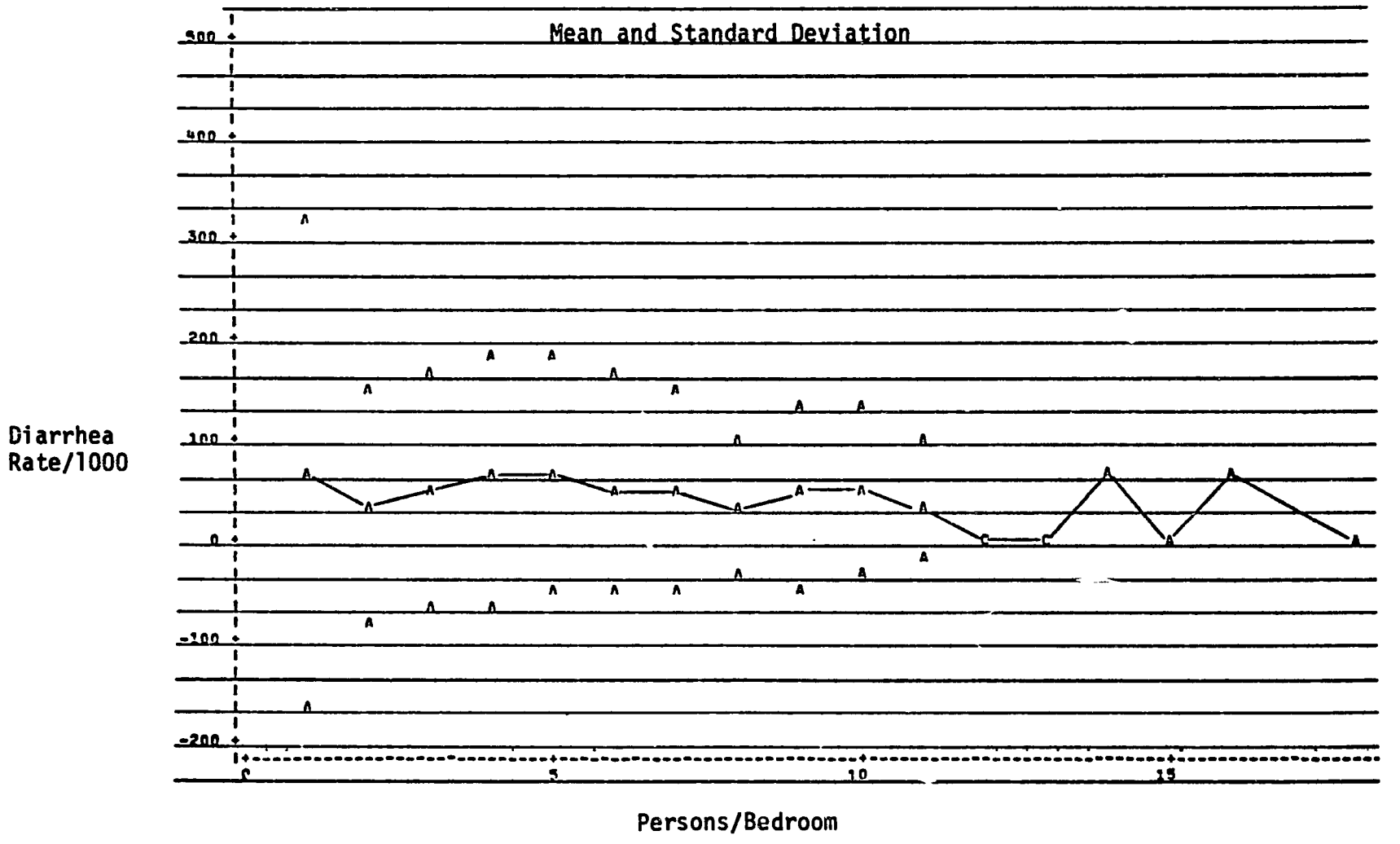
Diarrheal Morbidity Rate Versus Total Room Crowding Index
(Florida Aceituno)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded to nearest whole integer.

FIGURE IV.7

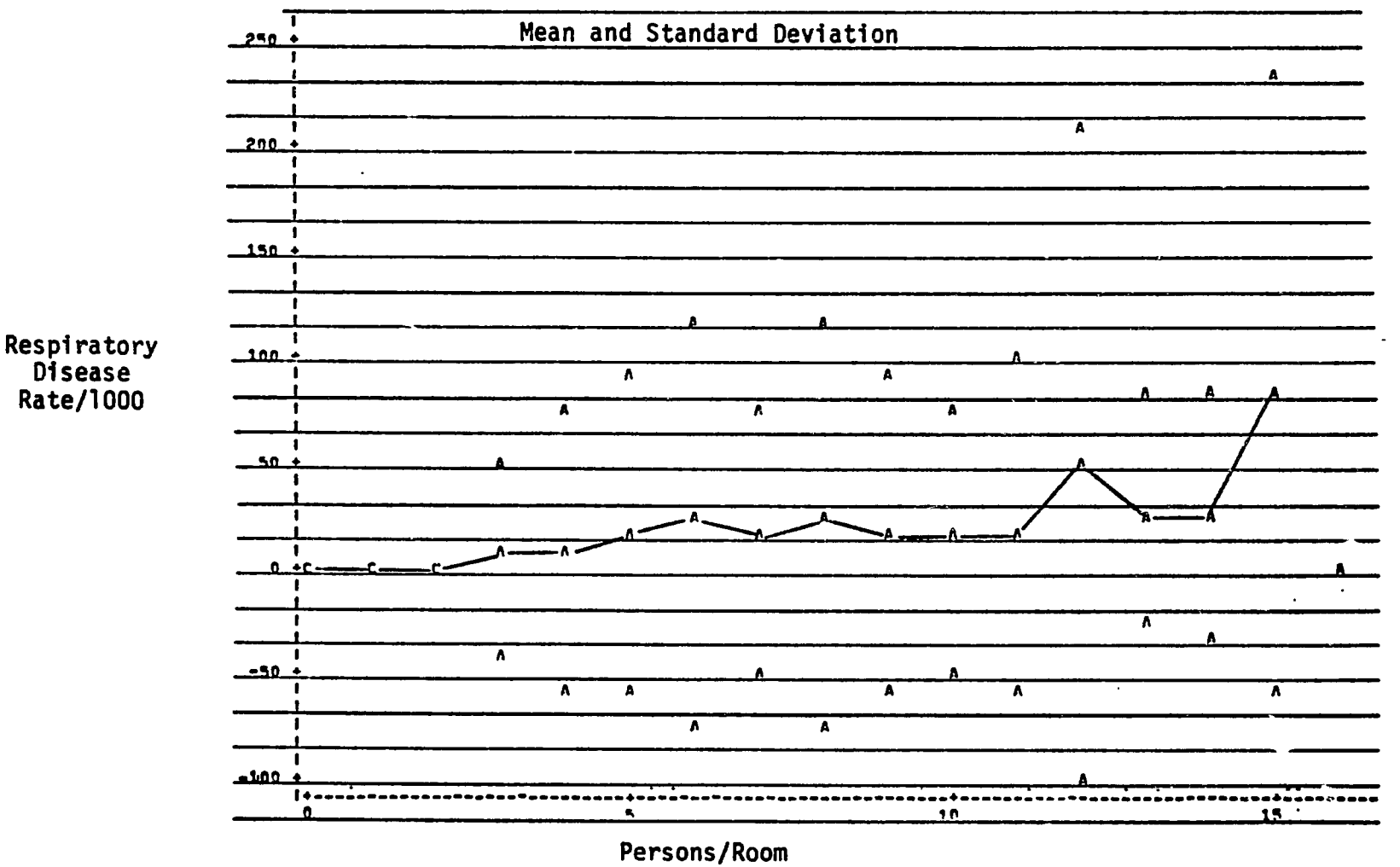
Diarrheal Morbidity Rate Versus Bedroom Crowding Index
(Florida Aceituno)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/Bedroom: rounded to nearest whole integer.

FIGURE IV.8

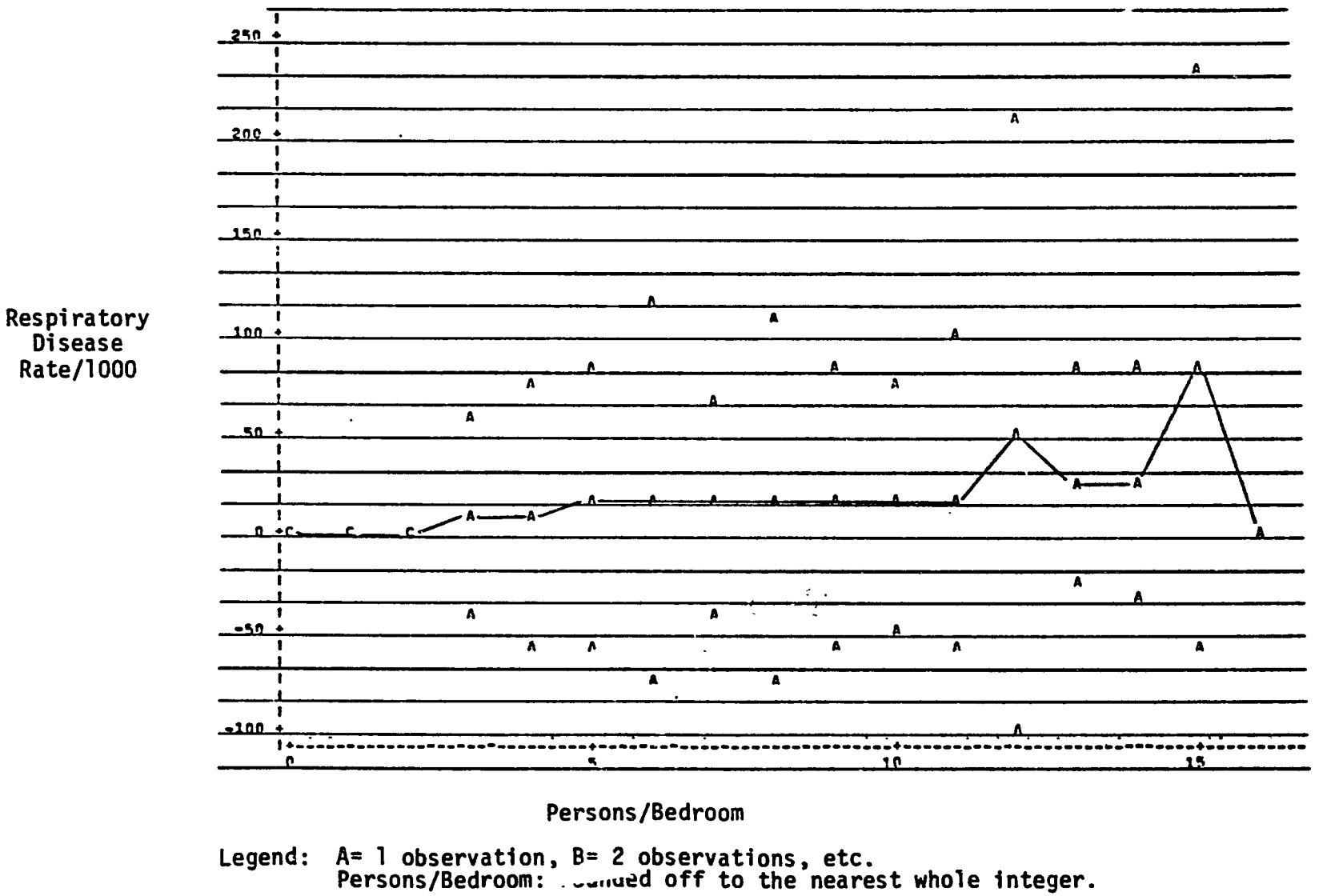
Respiratory Morbidity Rate Versus Total Room Crowding Index
(Guanagazapa)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded off to the nearest whole integer.

FIGURE IV.9

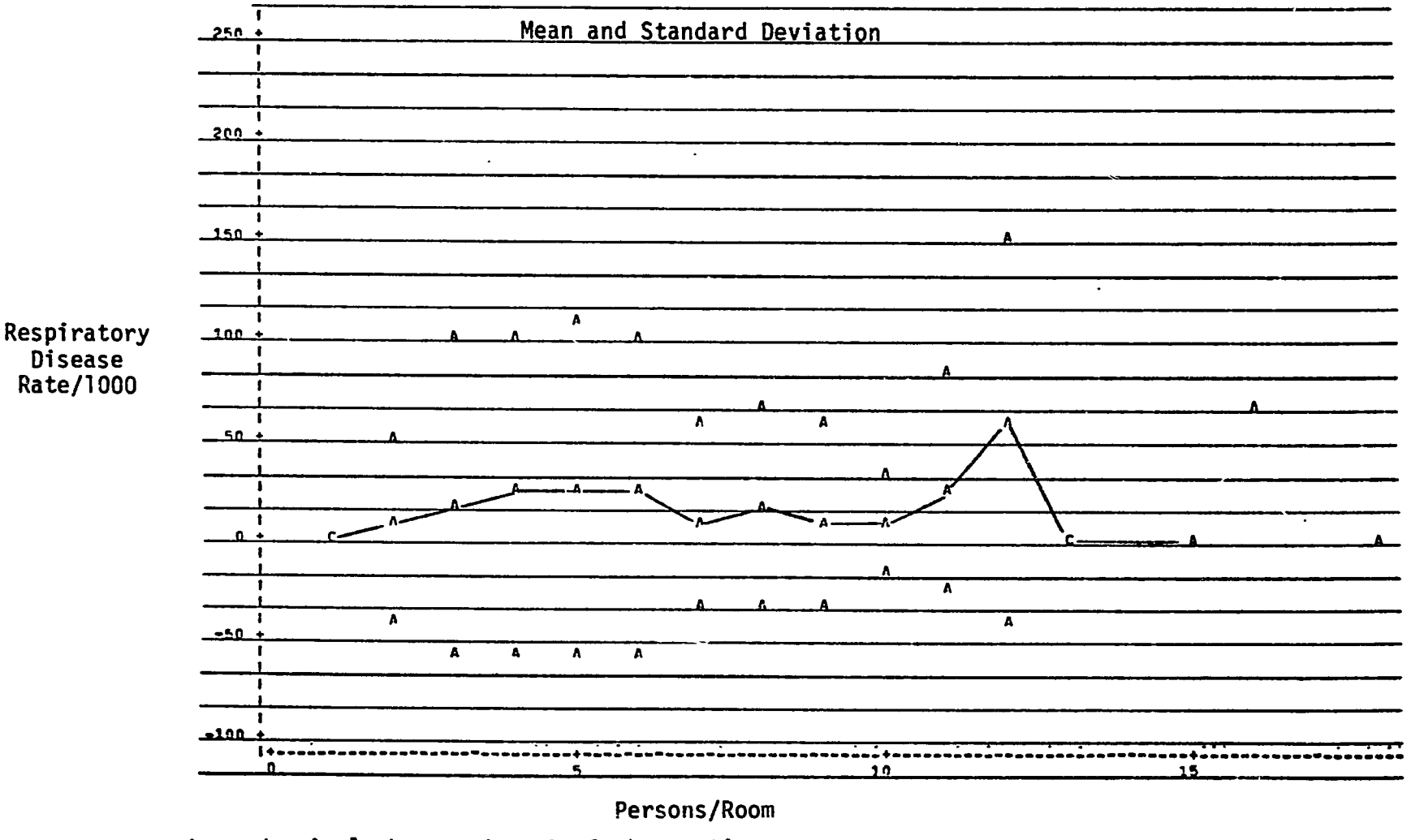
Respiratory Morbidity Rate Versus Bedroom Crowding Index
(Guanagazapa)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/Bedroom: rounded off to the nearest whole integer.

FIGURE IV.10

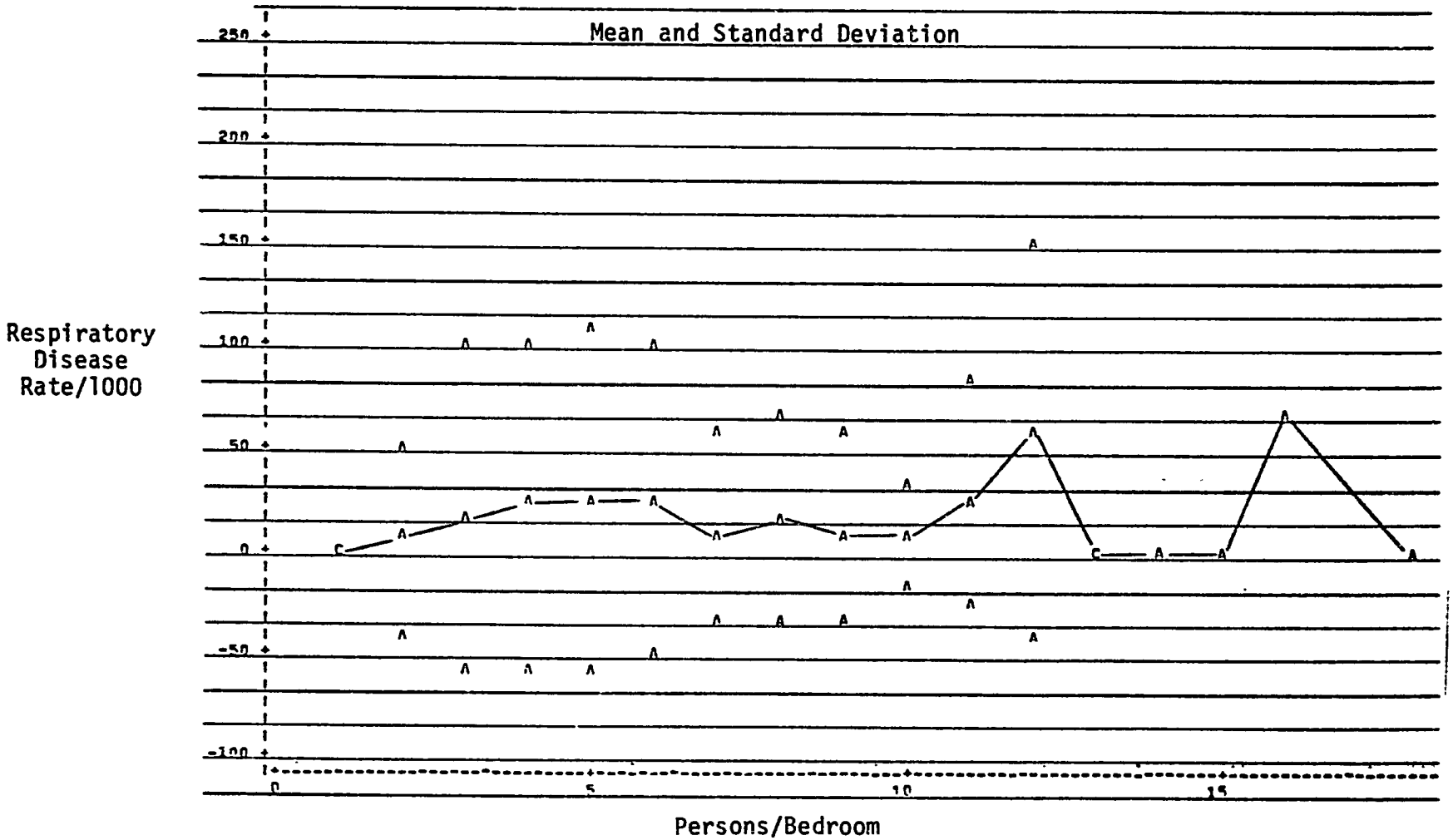
Respiratory Morbidity Rate Versus Total Room Crowding
(Florida Aceituno)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded to nearest whole integer.

FIGURE IV.11

Respiratory Morbidity Rate Versus Bedroom Crowding Index
(Florida Aceituno)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/bedroom: rounded to nearest whole integer.

Quality Survey (Form 26).

Unfortunately, perhaps, the results of these analyses may be succinctly summarized. The variables which were "controlled for" in the analyses, such as age, community, month (or quarter or season), and size of family were typically shown to have discernable effects on morbidity. The sizes of the estimates of the effects were different for the different types of morbidity and also varied from analysis to analysis, depending upon the "adjustment variables" being used.

In contrast, there were no sanitary status variables which showed persistent effects on morbidity. That is, if a statistically significant effect was found in one group, the effect would not be significant for another related group, as for example, a group with identical characteristics except for a difference in age or sex. Moreover, when statistically significant effects were plotted on graphs, the "effects" proved to be very indefinite.

One can conclude from these analyses that changes in sanitary quality of the magnitude observed in these villages did not produce striking changes in morbidity over the relatively short period of this study. Some very small trends or associations with sanitation may have been detected. For example, increased water consumption in Guanagazapa was associated with decreased diarrhea and skin infections in children aged 13-24 months, but the trends or associations are so small that it is not possible to "separate the signal from the noise." A large number of statistical tests were performed in these analyses and the proportion of "statistically significant" test results was near 5%, about what would be expected when testing at the 5% significance level. It was therefore difficult to determine if effects, such as the one noted above, are real or the result of random variability. Using scatter diagrams, in which morbidity is plotted against

water consumption [actually, $\log_{10}$ water consumption], it is apparent that even if an effect exists, it was quite small over the time period of this study and is masked by random variability in morbidity experience.

A comprehensive description of one statistical analysis, which indicates the complexity of the models and the number of variables involved, is presented here. This type of analysis was done for all variables of interest.

1. General Linear Model Analysis of Family Monthly Morbidity Data for Associations with Monthly Sanitation Survey Variables

The influence of water consumption and sanitary behavior upon morbidity was examined using the monthly family morbidity data. For each family, morbidity rates were computed each month for four categories of morbidity (respiratory diseases, skin infections, diarrhea, and infectious diseases). In this analysis, observations on a particular family in different months were treated as independent. For three of the disease categories (skin infections, respiratory diseases, and infectious diseases), the empirical evidence (i.e., month-to-month correlations over families) indicates that this assumption is justified. For diarrhea, correlation of "within family morbidity" was found, but the magnitude was so small that the effect on the results is minor. It should be noted that the effect of such correlations would be to increase bias in the tests of hypothesis. Thus for diarrhea, marginally significant results must be viewed with some caution.

General linear model techniques were used to examine the effect of the various predictor variables on the morbidity rates. The factors studied were:

a. Village. Florida Aceituno versus Guanagazapa

b. Family size. 1, 2, 3, 4, and 5+ family members

c. Month. Thirty-five calendar months for which morbidity data were available

d. Sanitary Condition Variables. An indication of whether or not a sanitary survey (Form 32) was made on this family during the month and, if so, sanitary condition as assessed by each of eleven questions from Form 32.

e. Longitudinal Sample Membership. An indication of whether or not this family was a member of the longitudinal sample.*

f. Water Consumption (in Guanagaza only). An indication of whether or not the family had piped water, and if so, monthly water consumption

For each of these factors, a number of indicator variables were created. The precise form of these variables will be described in a subsequent section.

In the course of the preliminary examination of these data, it became evident that the variance of the morbidity rates changed as a function of family size, large families showing greater variability. In order to deal with this, it was necessary to use weighted least squares techniques, a straightforward generalization of ordinary least squares (c.f. Searle, 1971; Bock, 1975).

2. General Description of the Models Fit

For practical purposes, one can consider that eight separate models were fit, one for each of the four morbidity categories in each village. At a later stage, the two "within village models" for each morbidity type were combined in order to assess interactions of the various other factors with village. The general structure of all eight models is identical. The model described in this section is thus the model applicable in each case. The form of the model is:

*The longitudinal sample is described in the Methodology report for the project. Membership in the sample is based on the participation of a family member in the Detailed Absorption Studies (Section VII).

$$Y_i = \sum_{j=1}^{p} X_{ij}\beta_1 = e_i \ , \ i=1,2,\ldots,N.$$

Y_i is the observed morbidity rate for the i-th family in a specific month (in FA, N=7715 observations; in GU, N=7619 observations). X_{ij} is the value of the i-th observation (family for a particular month) on the j-th "independent variable". These independent variables were computed from the factors listed above and described in the next section. In Florida-Aceituno 63 such variables were used while in Guanagazapa 65 were used.

$e_i = Y_i - \Sigma_j X_{ij}\beta_j$ is the observed morbidity rate (Y_i) minus the "model predicted" morbidity rate, $\Sigma_j X_{ij}\beta_j$. We assume e_i is random and arises from a distribution with a zero population mean and a population variance which depends upon community, family size, and type of morbidity rate.

It is not possible to know the exact values of the β_j, the model's primary parameters. The method of weighted least squares is used to estimate the β_j and the estimate of β_j is called b_j. The precision of the estimate, b_j, is indicated by its standard error.

3. Description of Independent Variables in the Model and Corresponding Primary Parameters

One or more independent variables were created from each of the factors listed above. Most of these were "indicator variables" which take on only values of 0 or 1. For example, one independent variable in the model was an indicator variable which corresponds to longitudinal family membership. This variable has a value of 1 if the observation comes from a longitudinal sample family and 0 otherswise. In some cases, more than one indicator variable was generated corresponding to family size. Every observation has a 1 in each of the indicator variables, its position depending on the number of people in the family, as shown in Table IV.15.

TABLE IV.15

Formation of Family Size Indicator Variables

Family Size	Indicator Variable 1	2	3	4
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1
≥5	0	0	0	0

Corresponding to each such variable is a β_j, one of the primary parameters. The model parameters, rather than the study variables, are used here because they are more meaningful.

The primary parameters were grouped to represent the effects on morbidity attributable to:

a. Family size (Variables: vvFAM1 - vvFAM4)

b. Calendar month (Variables: vvMNTH1 - vvMNTH35)

c. Environmental conditions (Variables: vOBSFAMO - vLATCL1)

d. Participation in the environmental survey (Variable: vHAV32)

e. Membership in the longitudinal sample (Variable: vLNGSAMP)

f. Having piped water and water consumption (Guanagazapa only). (Variables: GHAVWAT, GLOGFMWT).

[Note: vv denotes the letters FA or GU; v denotes the letter F or G, depending on the village involved.]

Monthly "Adjusted" means

The data for this analysis included 35 calendar months and the model includes one parameter for each month. The estimate of the parameter corresponding to a particular month is the adjusted mean morbidity rate

for the month for families satisfying the following conditions:

a. Family size: 5 or more

b. Month: the specified month

c. Environmental conditions: not surveyed

d. Participation in environmental survey: Not surveyed

e. Membership in longitudinal sample: Family not in longitudinal sample

f. Piped water supply: Family does not have access to piped water supply

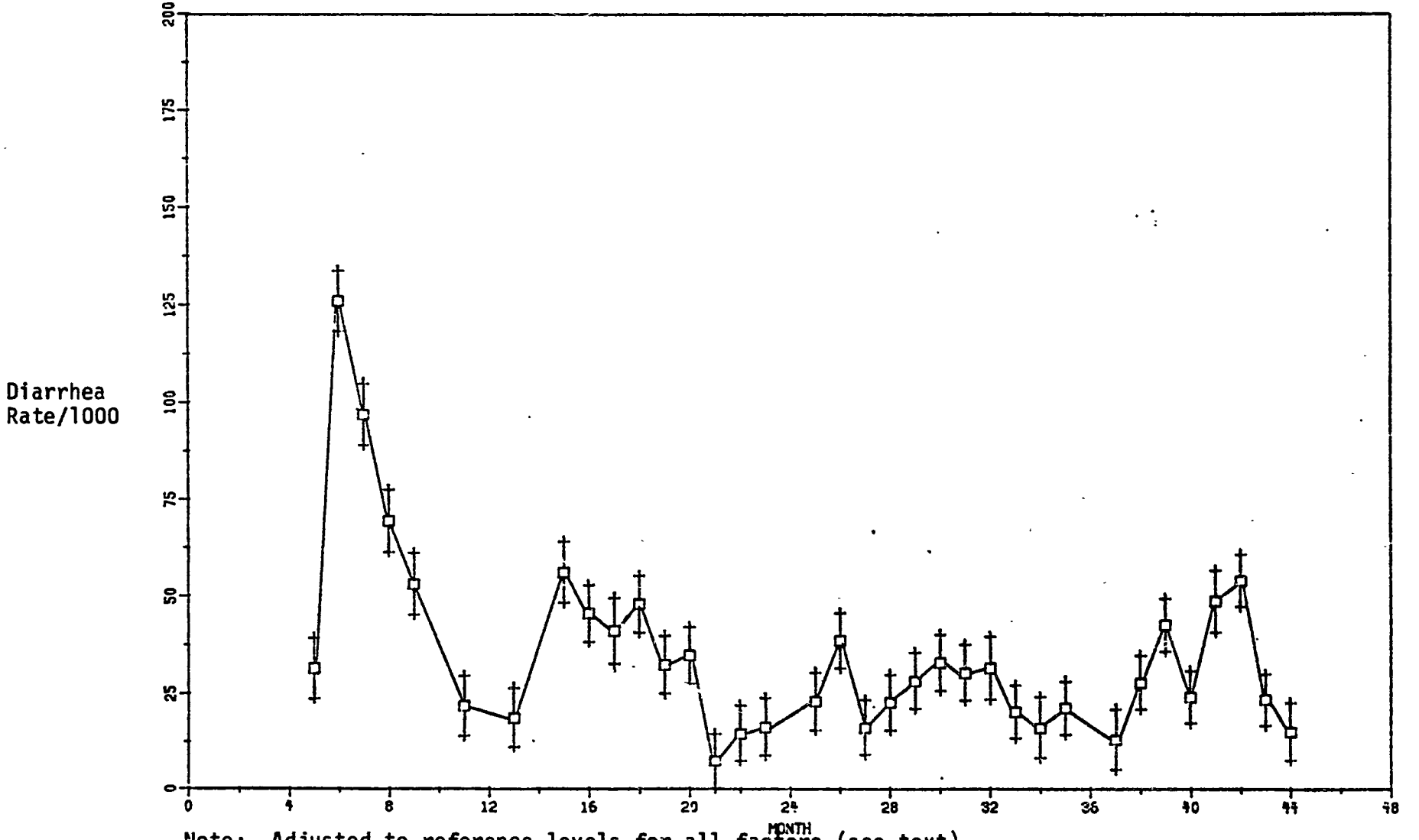
These conditions are called the "reference levels" of these factors.

For practival purposes, a separate model was fit to data from each of the two villages. Each monthly mean was "adjusted" for the other variables to reflect the values of the six variables given above. Thus, for example, the adjusted mean diarrheal morbidity rate for Guanagazapa families in May 1973 (month 7305) was 35.9 ± 7.2(adjusted mean ± standard error) incidents reported per thousand persons (Figure IV.12) while the corresponding rate in June, 1973 (7306) was 130.5 ± 7.1 (adjusted mean ± standard error). The corresponding rates in Florida Aceituno (Figure IV.12) were 52.9 ± 8.4 in May 1973 and 168.4 ± 8.3 in June, 1974. This large jump in diarrheal morbidity from the first to the second morbidity survey is discussed in additional detail in Chapter III.

The parameters (and estimates) corresponding to family size represent the average difference in morbidity rate between families of a given size and families having 5 or more members if all other factors are equal. Thus, the coefficient for family size = 1 (Table IV.16) has a value of -25.8 ± 4.4 (coefficient ± standard error). This means that in Guanagazapa, other factors being equal, single-person families had an average diarrheal

FIGURE IV.12

Adjusted Diarrheal Morbidity Rates In Guanagazapa By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

TABLE IV.16

Increments In Monthly Diarrheal Morbidity Rates Associated With Selected Parameters

	Florida Aceituno			Guanagazapa		
Parameter	Rate	S.E.	Significance	Rate	S.E.	Significance
Family Size = 1	-22.1	5.6	**	-25.8	4.4	**
Family Size = 2	-31.8	3.9	**	-10.3	4.1	*
Family Size = 3	- 7.2	3.7	NS	- 0.4	3.9	NS
Family Size = 4	4.2	3.8	NS	1.4	3.6	NS
...						
Surveyed, Form 32	118.3	71.3	NS	- 1.5	108.8	NS
...						
Longitudinal Sample	2.9	2.8	NS	2.2	2.6	NS
...						
Piped Water Supply	----------NA----------			20.5	15.1	NS

Legend: NS: $p>.05$; $/t/<1.96$
*: $p<.05$; $/t/\geq 1.96$
**: $p<.01$; $/t/\geq 2.58$

morbidity rate 25.8 ± 4.4 units below the rate for Guanagazapa families of 5 or more persons. Similarly, the family size =2 coefficient indicates Guanagazapa families of two persons had an average diarrheal morbidity rate 10.3 ± 4.1 units below the rate for Guanagazapa families of 5 or more persons. Families of 3 persons and those of 4 persons had essentially the same rates as the 5+ person families, the estimated difference being 0.4 ± 3.9 units lower for size 3 families and 1.4 ± 3.6 units higher for 4 person families. Table IV.16 presents the increments for mean diarrheal morbidity rates for families of sizes 1, 2, 3, and 4 compared to families of 5 or more persons averaged over months and for "reference levels" of the other factors.

The parameter corresponding to longitudinal sample membership represents the average difference in morbidity between families in and not in the longitudinal sample, holding the other factors constant at their reference levels. Thus, one can see from Table IV.16 that, in Guanagazapa, mean diarrheal morbidity for families in the longitudinal sample was 2.2 ± 2.6 units higher than the rate for families not in the sample. In Florida Aceituno, families in the longitudinal sample had mean diarrheal morbidity rates 2.9 ± 2.8 units higher than those not in the longitudinal sample, with all other factors again held constant at their reference levels.

One parameter in the model corresponds to the incremental effect on morbidity of having been surveyed with a Form 32 in a given month in comparison to the reference condition of not having been surveyed. Thus, on the average (Table IV.16), families who were surveyed had diarrheal morbidity rates 118.3 ± 71.6 units higher in Florida Aceituno and 1.5 ± 108.7 units lower in Guanagazapa than families who were not surveyed.

In addition, the model has 11 pairs of parameters, each pair corresponding to one sanitation variable from Form 32. The reference level for each Form 32 variable is "not surveyed". For each variable, the first of the two parameters represents the increment in morbidity associated with a negative response for the particular Form 32 variable. "Negative response" means that response which, for any particular item, corresponds to a less sanitary condition regardless of whether this was coded as a yes or a no answer to a particular sanitary condition. Diarrheal morbidity for families in Florida Aceituno with a negative response to the variable K_FLIES (i.e., families who had flies in the kitchen) was on the average, 6.1 ± 16.5 units lower than that for families who were not surveyed (Table IV.17). The second parameter represents the increment in morbidity corresponding to a positive response in relation to the negative category (not in relation to the reference level). Thus, families with a positive response to K_FLIES in Florida Aceituno had a mean diarrheal morbidity rate -10.5 ± 7.9 units lower than families with a negative response. For K_FLIES, then, the average difference in diarrheal morbidity between the families not surveyed and those with positive responses is 6.9 ± 10.5 = 17.4 units. The pairs of parameters for the ten other Form 32 variables were defined by the same analogy.

In Guanagazapa, the model has two parameters for water consumption. The first is simply the incremental effect of having a water tap beyond the reference level of "no tap". Families with a water faucet had an average rate of diarrheal morbidity 20.5 ± 15.1 units higher than that of families without. The second water parameter is the coefficient of the $\log_{10}$ of the monthly family water consumption in liters per person per day. Thus, it is the slope of a regression line relating morbidity

TABLE IV.17

Increment in Monthly Diarrheal Morbidity Rate Associated With Sanitary Variables (Form 32)

VARIABLE NAME AND DESCRIPTION	FLORIDA ACEITUNO						GUANAGAZAPA					
	RESPONSE						RESPONSE					
	-			+			-			+		
	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.
OBSFAM Observation about family	42.1	32.7	NS	-12.8	8.0	NS	21.2	37.1	NS	-11.1	5.7	NS
INFCLOTH State of informant's clothes	-128.1	80.7	NS	2.7	8.2	NS	-13.3	150.6	NS	.3	5.5	NS
K_GARFLR Kitchen - Garbage on floor	30.1	96.7	NS	-1.5	6.1	NS	-1.3	46.9	NS	-2.4	5.0	NS
K_BARRIR Kitchen - Barrier against animals	-62.4	164.0	NS	8.1	24.7	NS	-27.3	64.0	NS	-7.3	8.0	NS
K_ANIMAL Animals in kitchen	51.0	132.1	NS	5.8	5.2	NS	20.7	56.9	NS	3.9	4.4	NS
K_FDCOV Cooked food covered	6.7	13.4	NS	5.0	7.6	NS	6.7	9.5	NS	-8.7	5.3	NS
K_FLIES Flies on food	-6.1	16.5	NS	-10.5	7.9	NS	3.7	9.0	NS	4.3	5.2	NS
K_CONTCV Water container covered	6.2	7.1	NS	-8.4	6.1	NS	-.3	5.0	NS	5.2	6.2	NS
O_GARBAG Garbage outside	18.9	72.9	NS	1.3	6.9	NS	-26.6	132.9	NS	9.1	8.8	NS
O_SWEPT Yard swept	-59.0	60.8	NS	-2.1	6.1	NS	32.9	74.2	NS	-8.2	8.4	NS
O_LATCL Latrine Clean	-12.9	7.3	NS	-5.7	9.7	NS	-1.1	5.9	NS	-5.5	6.7	NS

Note: NS: $p>.05$; $/t/<1.96$
*: $p>.05$; $/t/\geq 1.96$
**: $p<.01$; $/t \geq 2.58$

rate to amount of water consumed. The estimate of this slope is -6.3 ± 3.8 units for this effect. Hence, the trend of the relationship is for diarrheal morbidity to decrease as water consumption increases (with all other factors held constant).

Description of Hypotheses Tested and Secondary Parameters Estimated

The model was constructed to answer most questions relating to many of the primary parameters. In addition, there were a number of secondary parameters (linear combinations of the primary parameters) which were estimated and about which corresponding hypotheses were tested.

1. Questions Involving Primary Parameters

a. What was the extent of the association between sanitary conditions (as indexed by the eleven Form 32 items)*and morbidity rates?

b. In Guanagazapa, what was the extent of the linear relationship between the log of water consumption and morbidity?

c. What was the effect of family size (categorized as 1, 2, 3, 4, 5+ persons) on morbidity?

d. Was there an effect on reported morbidity by simply having been surveyed with Form 32 in a particular month?

e. What was the difference in morbidity rates between families in the longitudinal sample and those not in the sample?

These questions were directly addressed by the primary parameters of the model. Note that each of these questions was evaluated within each of the two variables. The differential effects of these factors (between the two villages) are also obviously of interest. They were estimated as secondary parameters.

2. Estimates of Secondary Parameters and Corresponding Questions of Interest

*Copies of the forms are included in the project report and appendix on methodology.

a. Was there significant variability in morbidity from month to month? This was assessed by taking the difference between the estimated morbidity rate for August 1976 and the estimated rate for each of the other months. These are differences in the primary parameters for months defined earlier. All other factors were controlled at their reference levels. The test of the hypothesis of no monthly differences is then a simultaneous test of whether all 34 of these secondary parameters are equal to zero.

b. Was the morbidity rate homogeneous from month to month within quarters? That is, were there significant differences in morbidity rates among the months within each quarter? This question was addressed one quarter at a time (for the eight quarters in which all three months of morbidity data was available) and simultaneously over all thirteen quarters in which at least two months of morbidity data was available.

c. Were there significant differences among average quarterly morbidity rates? This was done by averaging the monthly morbidity rates (estimates of primary parameters) within each quarter to form secondary parameters which estimate average quarterly morbidity and then taking differences among these averages.

d. Were there significant differences among seasonal (6 month) average morbidity rates? This is analogous to (c.) above.

e. Were the rainy and dry seasons different with respect to average morbidity?

In addition, the interactions of all of these parameters with community were estimated and the corresponding hypotheses were tested.

Results of the Analysis

The results of these analyses for both primary and secondary parameters are given below.

1. Results Involving Primary Parameters

a. Sanitary Conditions. The estimates of the parameters associated with the various sanitary conditions are presented in Tables IV.17, IV.18, IV.19 and IV.20. The general pattern of results in these tables is rather clear. None of the sanitary behaviors, as measured by Form 32, were substantially related to changes in morbidity in either village or for any of the four morbidity categories. Furthermore (Tables IV.16, IV.21, IV.22 and IV.23), there was no significant difference in average morbidity between families surveyed with Form 32 and those who were not. As a final check on the effect of the sanitary condition variables on morbidity, a simultaneous test of the influence of all 11 pairs of effects was performed. It would be possible, although uncommon, for each of the 22 individual tests of significance on Form 32 variables to be non-significant, yet for the variables to have a joint effect (acting all at once) which is significant. These tests were performed for each community and for each of the four morbidity categories. Seven of the eight tests were non-significant while the eighth (skin infection in Florida Aceituno) was marginally significant. Thus, in summary, sanitary conditions, as measured by Form 32, appeared to have no substantial effect on morbidity rates.

b. Water Supply. The relationship between water supply and morbidity in Guanagazapa also appeared to be slight. There were no significant intercepts for the effect of having piped water (Tables IV.15, IV.21, IV.22 and IV.23). Furthermore, none of the slope parameters (for the

TABLE IV.18

Increment in Monthly Skin Infection Morbidity Rate Associated with Sanitary Variables (Form 32)

VARIABLE NAME AND DESCRIPTION	FLORIDA ACEITUNO						GUANAGAZAPA					
	RESPONSE						RESPONSE					
	-			+			-			+		
	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.
OBSFAM Observation about family	-47.9	12.4	**	3.3	3.0	NS	17.9	21.8	NS	- 1.9	3.4	NS
INFCLOTH State of informant's clothes	52.4	30.7	NS	-3.7	3.1	NS	-13.1	88.8	NS	- 2.6	3.2	NS
K_GARFLR Kitchen - Garbage on floor	5.0	36.7	NS	-1.3	2.3	NS	18.0	27.6	NS	- 2.1	3.0	NS
K_BARRIR Kitchen - Barrier against animals	- 9.4	62.3	NS	-7.1	9.4	NS	21.2	37.7	NS	-0.1	4.7	NS
K_ANIMAL Animals in kitchen	- 2.1	50.2	NS	.7	2.0	NS	-43.3	33.6	NS	4.5	2.6	NS
K_FDCOV Cooked food covered	3.2	5.1	NS	-2.0	2.9	NS	1.9	5.6	NS	-4.8	3.1	NS
K_FLIES Flies on food	.2	6.3	NS	-1.4	3.0	NS	-4.1	5.3	NS	2.8	3.1	NS
K_CONTCV Water container covered	-1.6	2.7	NS	6.1	2.3	**	3.4	2.9	NS	1.5	3.7	NS
O_GARBAG Garbage outside	8.6	27.6	NS	-7.3	2.6	**	- .8	78.4	NS	-5.9	5.2	NS
O_SWEPT Yard swept	4.1	23.1	NS	1.7	2.3	NS	12.8	43.7	NS	7.5	5.0	NS
O_LATCL Latrine Clean	2.0	2.8	NS	2.4	3.7	NS	- 2.8	3.5	NS	2.9	2.9	NS

Note: NS: $p > .05$; $/t/ < 1.96$
*: $p < .05$; $/t/ \geq 1.96$
**: $p < .01$; $/t/ \geq 2.58$

TABLE IV.19

Increment in Monthly Respiratory Disease Morbidity Rate Associated With Sanitary Variables (Form 32)

VARIABLE NAME AND DESCRIPTION	FLORIDA ACEITUNO						GUAMAGAZAPA					
	RESPONSE						RESPONSE					
	-			+			-			+		
	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.
OBSFAM Observation about family	38.1	41.6	NS	- 12.3	10.1	NS	- 53.4	59.1	NS	- 1.5	9.2	NS
INFCLOTH State of informant's clothes	- 73.1	102.7	NS	8.7	10.4	NS	0.07	240.1	NS	1.9	8.8	NS
K_GARFLR Kitchen - Garbage on floor	53.9	123.0	NS	- 6.9	7.7	NS	139.4	74.7	NS	- 10.9	8.1	NS
K_BARRIR Kitchen - Barrier against animals	-184.6	208.6	NS	- 29.3	31.5	NS	-119.9	102.1	NS	23.9	12.7	NS
K_ANIMAL Animals in kitchen	146.9	168.1	NS	8.1	6.6	NS	- 13.2	90.8	NS	6.9	6.9	NS
K_FDCOV Cooked food covered	12.1	17.1	NS	-12.3	9.7	NS	20.5	15.2	NS	-23.3	8.5	**
K_FLIES Flies on food	- 6.5	21.0	NS	2.5	10.1	NS	-12.1	14.4	NS	20.5	8.3	*
K_CONTCV Water container covered	6.9	9.0	NS	11.5	7.8	NS	-16.5	7.9	*	1.9	9.9	NS
O_GARBAG Garbage outside	27.8	92.6	NS	12.2	8.8	NS	57.5	211.9	NS	-7.9	14.1	NS
O_SWEPT Yard swept	-36.3	77.4	NS	-16.9	7.7	*	33.8	118.3	NS	3.8	13.5	NS
O_LATCL Latrine Clean	13.8	9.3	NS	-33.6	12.4	**	-6.8	9.4	NS	15.9	10.6	NS

Note: NS: $p>.05$; $/t/<1.96$
*: $p>.05$; $/t/\geq 1.96$
**: $p<.01$; $/t/\geq 2.58$

TABLE IV.20

Increments in Monthly Infectious Disease Morbidity Rate Associated With Sanitary Variables (Form 32)

VARIABLE NAME AND DESCRIPTION	FLORIDA ACEITUNO						GUANAGAZAPA					
	RESPONSE						RESPONSE					
	-			+			-			+		
	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.	RATE	SE	SIG.
CBSFAM Observation about family	10.5	19.3	NS	-1.1	4.7	NS	-12.6	24.9	NS	-0.6	3.8	NS
INFCLOTH State of informant's clothes	-16.5	47.7	NS	-4.9	4.8	NS	15.6	101.3	NS	-3.1	3.7	NS
K_GARFLR Kitchen - Garbage on floor	-213.0	57.1	**	-2.5	3.6	NS	-2.3	31.5	NS	4.8	3.4	NS
K_BARRIR Kitchen - Barrier against animals	222.6	96.9	*	-1.8	14.6	NS	-5.0	43.1	NS	-4.4	5.4	NS
K_ANIMAL Animals in kitchen	-0.43	78.1	NS	-1.3	3.1	NS	10.5	38.3	NS	-6.5	2.9	*
K_FDCOV Cooked food covered	-7.9	7.9	NS	0.8	4.5	NS	5.8	6.4	NS	1.2	3.6	NS
K_FLIES Flies on food	3.0	9.8	NS	-2.8	4.7	NS	-5.4	6.1	NS	2.6	3.5	NS
K_CONTCV Water container covered	8.0	4.2	NS	-0.9	3.6	NS	-0.0	3.3	NS	-1.0	4.2	NS
O_GARBAG Garbage outside	-6.2	42.5	NS	-1.8	4.1	NS	-14.8	89.4	NS	-0.9	5.9	NS
O_SWEPT Yard swept	13.1	35.9	NS	-0.3	3.6	NS	27.3	49.9	NS	-2.6	5.7	NS
O_LATCL Latrine Clean	6.1	4.3	NS	-10.9	5.8	NS	2.9	3.9	NS	-5.2	4.5	NS

Note: NS: $p>.05$; $/t/<1.96$
*: $p<.05$; $/t/\geq 1.96$
**: $p<.01$; $/t/\geq 2.58$

TABLE IV.21

Increments In Monthly Skin Infection Morbidity Rates Associated With Selected Parameters

	Florida Aceituno			Guanagazapa		
Parameter	Rate	S.E.	Significance	Rate	S.E.	Significance
Family Size = 1	0.4	2.1	NS	-9.2	2.6	**
Family Size = 2	- 1.0	1.5	NS	-1.4	2.4	NS
Family Size = 3	1.5	1.4	NS	0.1	2.3	NS
Family Size = 4	1.6	1.5	NS	6.5	2.1	**
...						
Surveyed, Form 32	-10.2	27.1	NS	-5.1	64.1	NS
...						
Longitudinal Sample	- 0.2	1.1	NS	1.1	1.5	NS
...						
Piped Water Supply	----------NA----------			-3.5	8.9	NS

Legend: NS: $p>.05$; $/t/<1.96$
*: $p<.05$; $/t/\geq 1.96$
**: $p<.01$; $/t/\geq 2.58$

TABLE IV.22

Increments In Monthly Respiratory Disease Morbidity Rates Associated With Selected Parameters

	Florida Aceituno			Guanagazapa		
Parameter	Rate	S.E.	Significance	Rate	S.E.	Significance
Family Size = 1	20.0	7.1	**	- 9.6	7.0	NS
Family Size = 2	4.8	4.9	NS	-13.2	6.6	*
Family Size = 3	6.0	4.7	NS	- 0.4	6.2	NS
Family Size = 4	6.0	4.7	NS	-13.3	5.7	*
...						
Surveyed, Form 32	36.4	90.7	NS	-54.2	173.3	NS
...						
Longitudinal Sample	11.4	3.6	**	- 7.7	4.1	NS
...						
Piped Water Supply	----------NA----------			19.6	24.1	NS

Legend: NS: $p>.05$; $/t/<1.96$
*: $p<.05$; $/t/\geq 1.96$
**: $p<.01$; $/t/\geq 2.58$

TABLE IV.23

Increments In Monthly Infectious Disease Morbidity Rates Associated With Selected Parameters

	Florida Aceituno			Guanagazapa		
Parameter	Rate	S.E.	Significance	Rate	S.E.	Significance
Family Size = 1	- 8.7	3.3	**	-12.0	2.9	**
Family Size = 2	-10.9	2.3	**	- 5.3	2.8	NS
Family Size = 3	- 5.7	2.2	**	- 4.4	2.6	NS
Family Size = 4	4.6	2.3	*	3.4	2.4	NS
...						
Surveyed, Form 32	- 2.9	42.1	NS	-22.0	73.1	NS
...						
Longitudinal Sample	- 0.3	1.6	NS	2.2	1.7	NS
...						
Piped Water Supply	----------NA----------			17.4	10.2	NS

Legend: NS: $p>.05$; $/t/<1.96$
*: $p<.05$; $/t/\geq 1.96$
**: $p<.01$; $/t/\geq 2.58$

regression of morbidity as a function of water consumption) were significantly different from zero. In summary, these results show no relationship between water supply and the morbidity rate.

c. Family Size. Family size had a substantial effect on morbidity rates, especially for infectious diseases and diarrhea. Tables IV.16, IV.17, IV.20, IV.21, IV.22 and IV.23 present the estimates of increments in morbidity rates for families of size 1 through 4 when compared to larger families. In particular, families of size 1 reported significantly lower morbidity rates in every case except for skin infection in Florida Aceituno and respiratory diseases in both villages. In general, morbidity rate increases with increasing family size up to three persons.

d. Effect of Being Surveyed with Form 32. There was no significant difference in morbidity rates between families who were and were not surveyed in a given month. Estimates of the effects with standard errors and significance levels are presented in Tables IV.16, IV.21, IV.22 and IV.23.

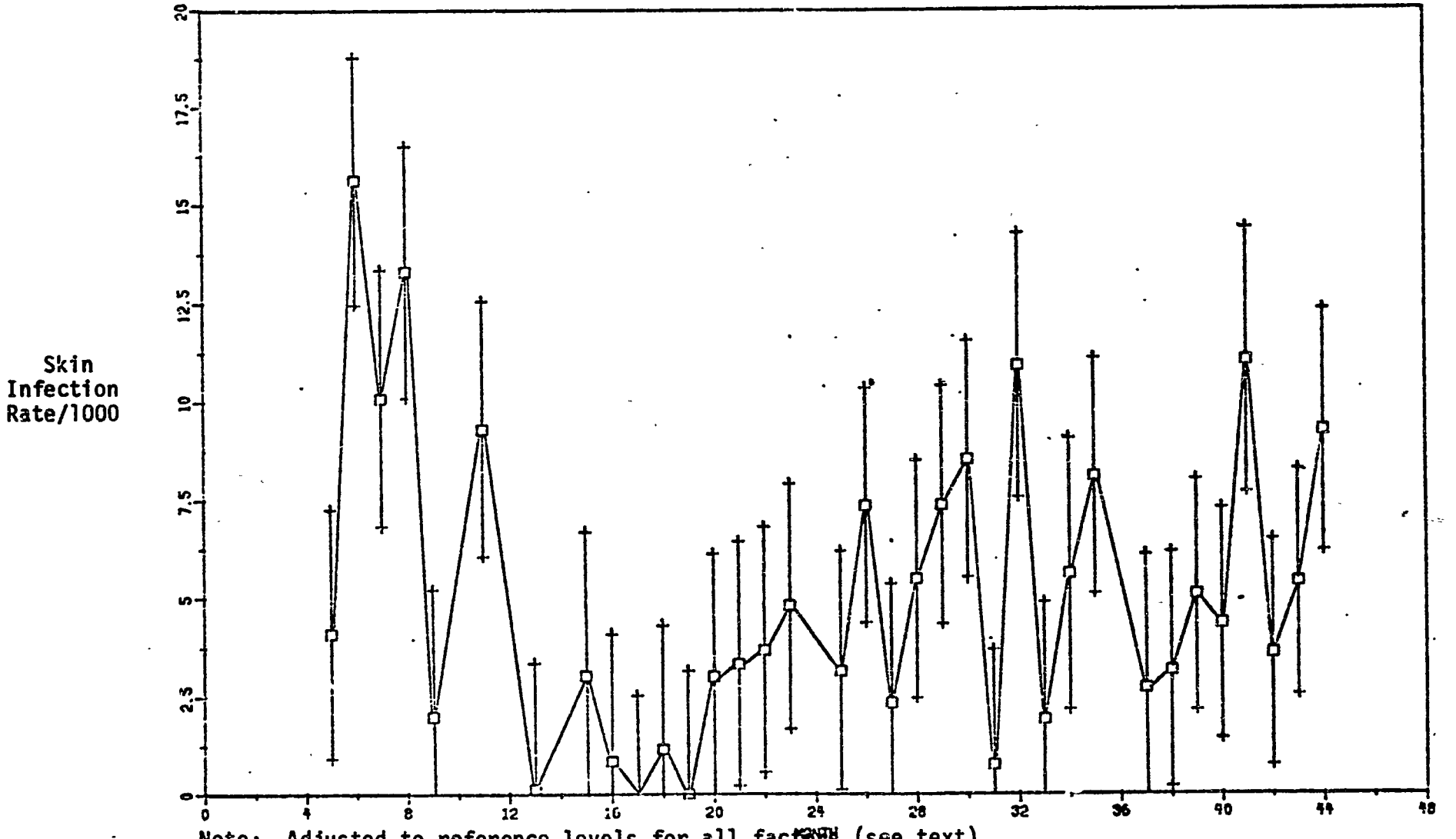
e. Longitudinal Sample Membership. As shown in Tables IV.16 and IV.21 through IV.23, longitudinal sample members did not differ significantly from non-members in mean morbidity rates.

2. Results Involving Secondary Parameters

a. Monthly Variability. The results of the significance tests clearly show significant differences in morbidity rates from month to month in each village and for each morbidity category ($p < .01$ in every case). Thus, it was clear that the mean morbidity rates in the two villages did change significantly over time. Figures IV.12 through IV.19 are plots of the adjusted mean monthly morbidity rates for each of the four morbidity categories in the two groups. These were adjusted to the reference levels for all factors. The boxes represent the adjusted means, while

FIGURE IV.13

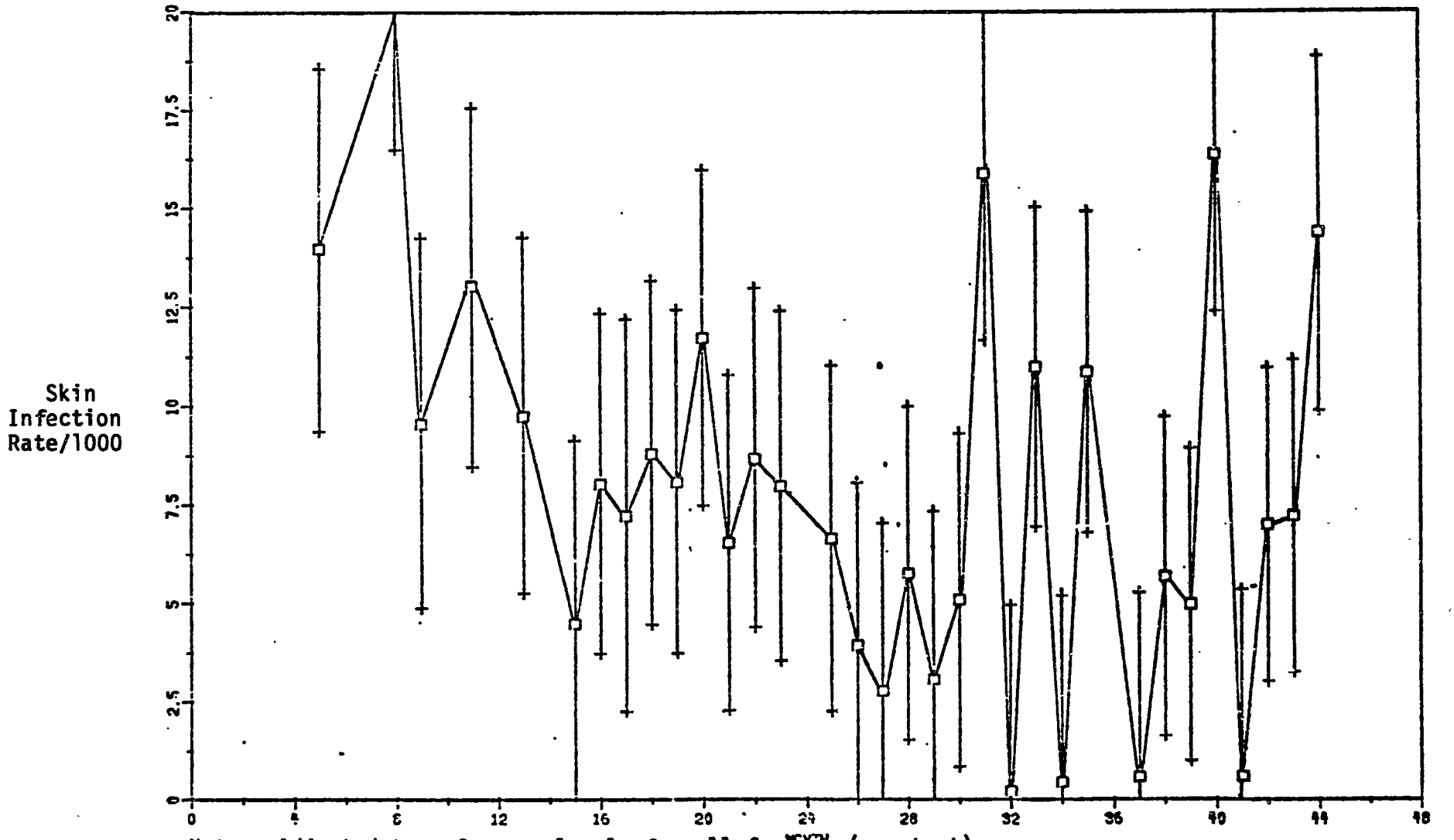
Adjusted Skin Infection Rates In Florida Aceituno By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

FIGURE IV.14

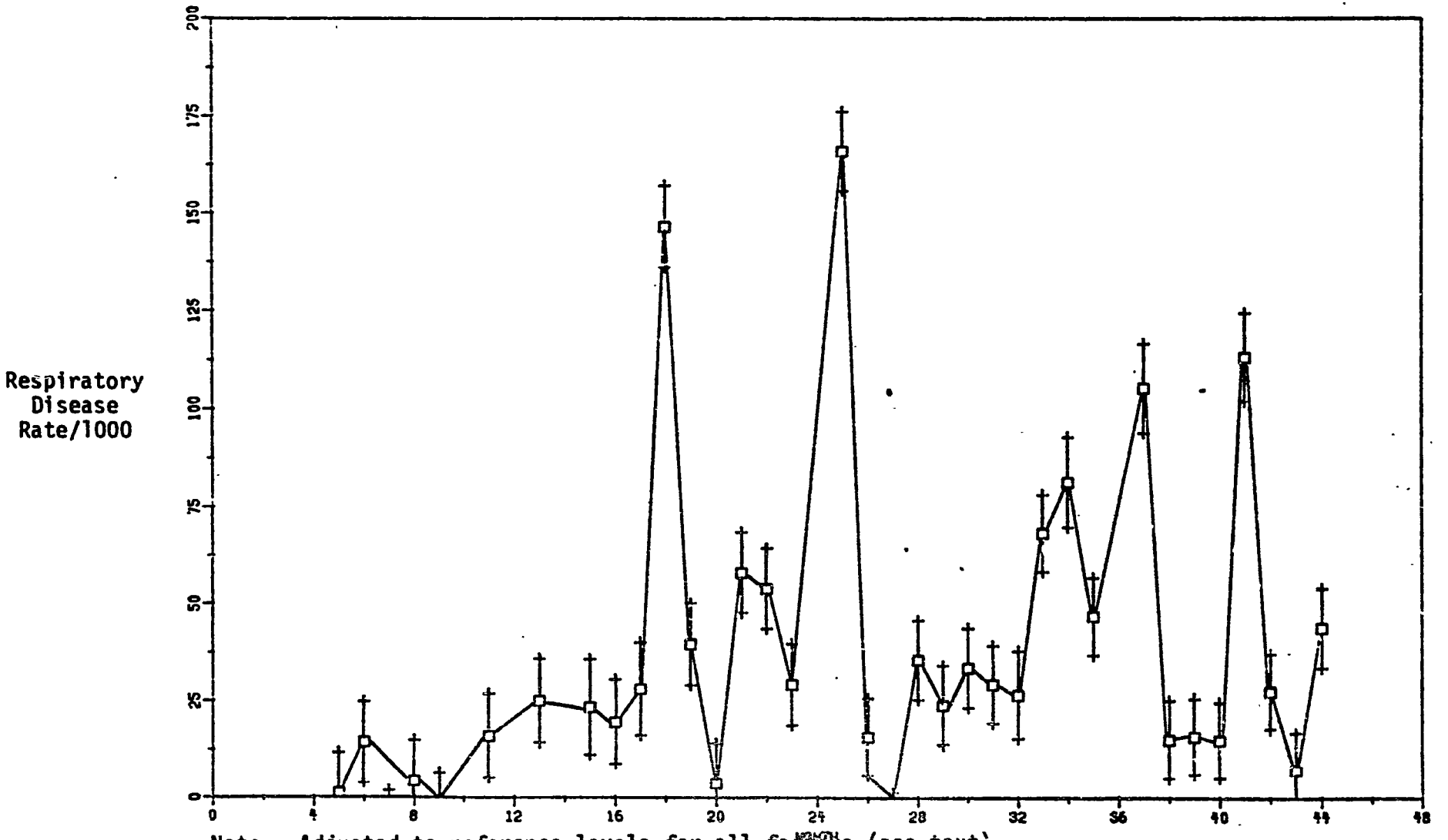
Adjusted Skin Infection Rates In Guanagazapa By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

FIGURE IV.15

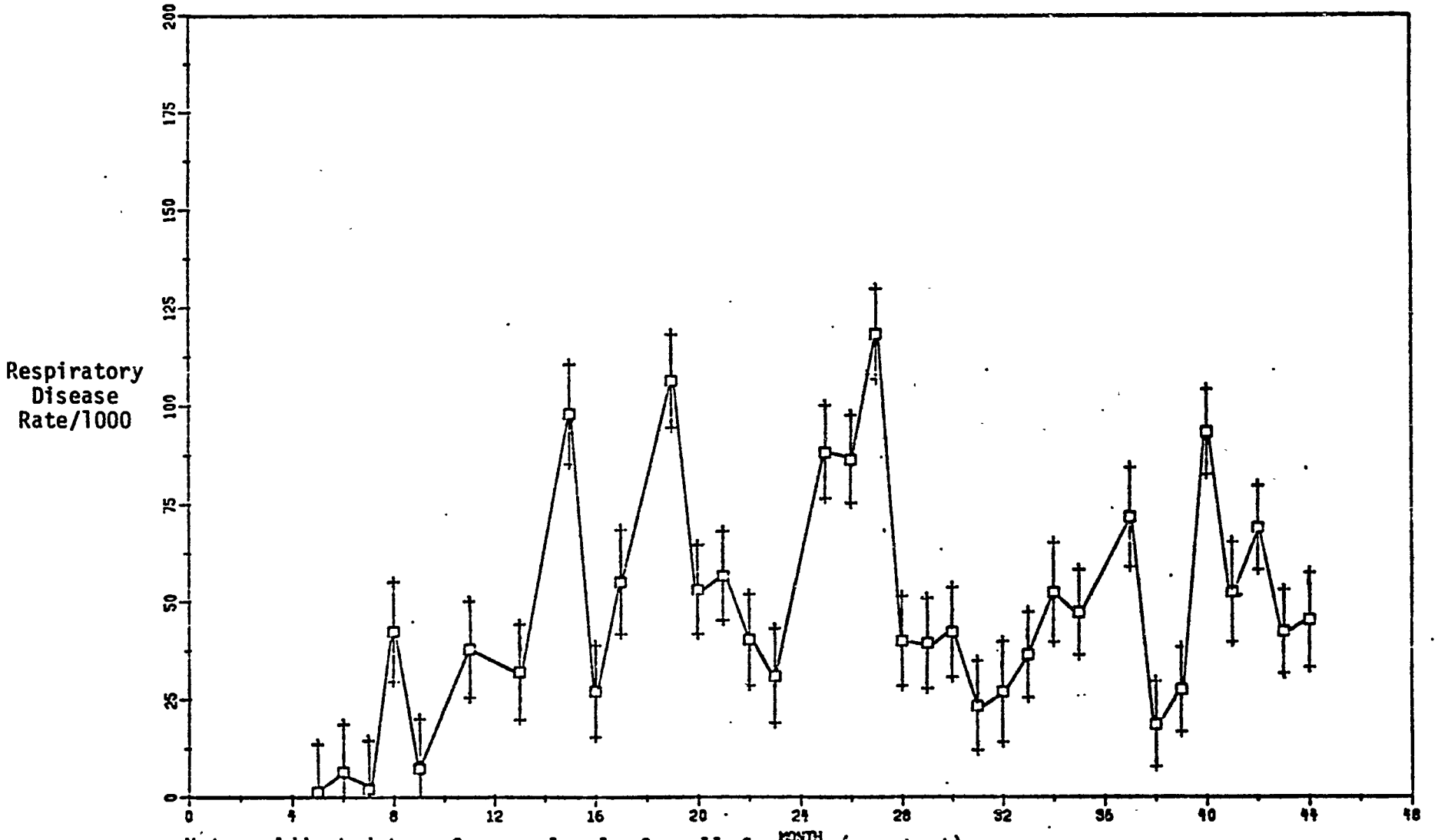
Adjusted Respiratory Morbidity Rates In Florida Aceituno By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

FIGURE IV.16

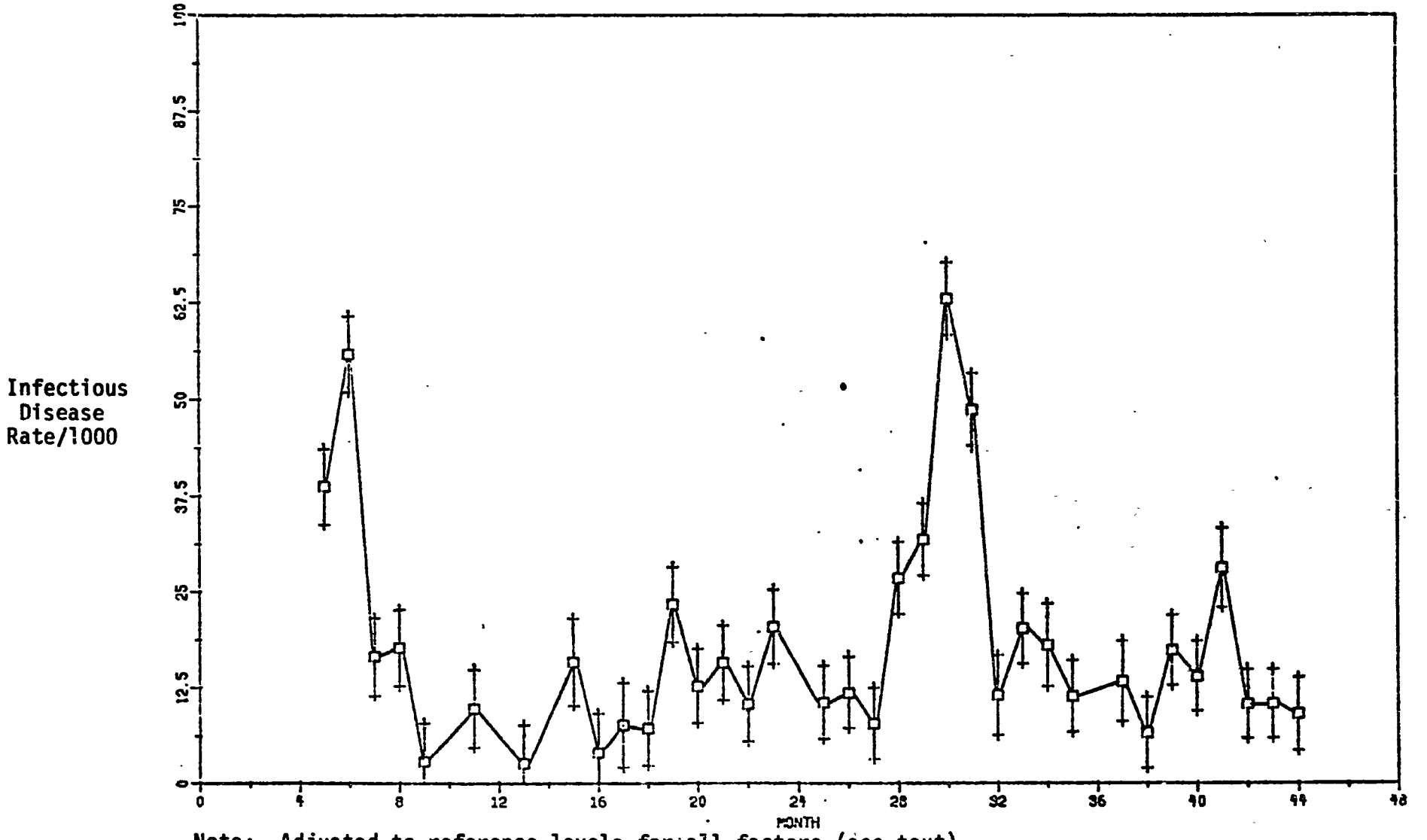
Adjusted Respiratory Morbidity Rates In Guanagazapa By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

FIGURE IV.17

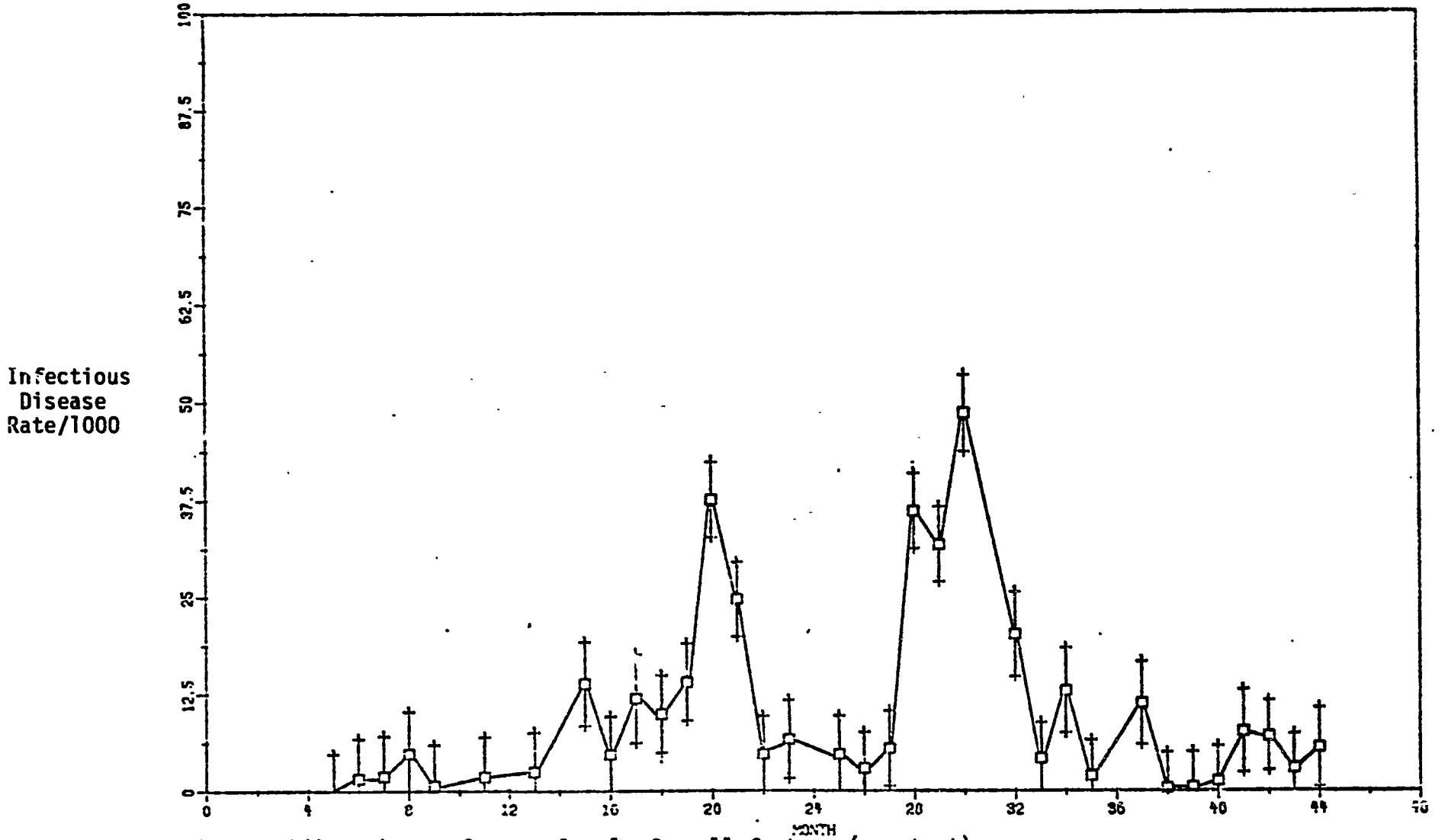
Adjusted Infectious Disease Rates In Florida Aceituno By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

FIGURE IV.18

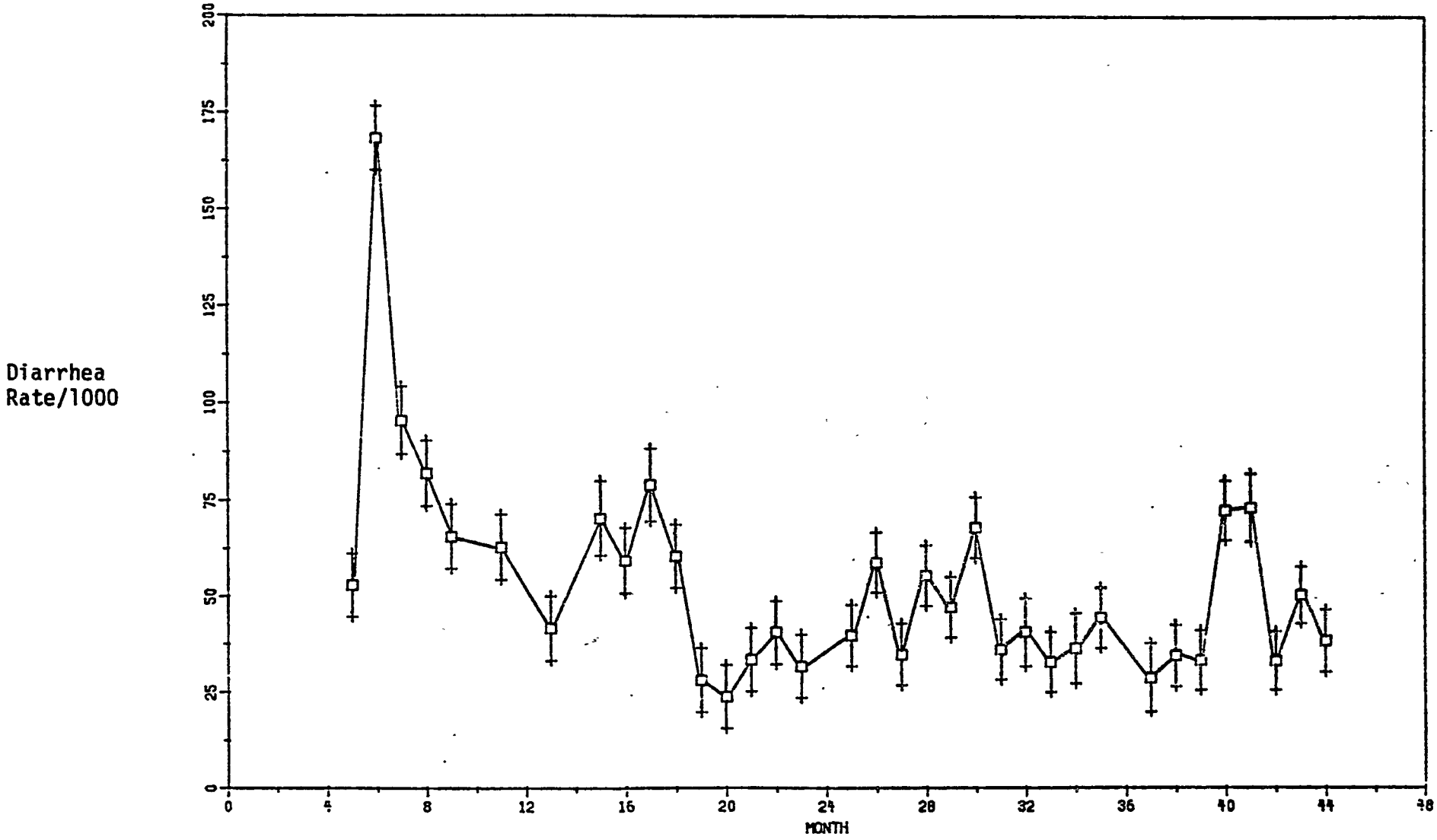
Adjusted Infectious Disease Rates In Guanagazapa By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

FIGURE IV.19

Adjusted Diarrheal Morbidity Rates In Florida Aceituno By Month
(Mean and Standard Error)



Note: Adjusted to reference levels for all factors (see text).

the vertical lines above and below the boxes represent one standard error, and indicate the variability around the mean.

b. Homogeneity Within Quarters. The equality of the monthly rates within quarters was tested for all those quarters in which two or more months of morbidity data was collected. The "within quarter" variability was significant for all disease categories in each village ($p < .05$ in all cases, $p < .01$ for seven of the eight tests). The vast majority of the individual quarter tests were also significant.

c. Differences Between Average Quarterly Morbidity. The quarterly average morbidity rates also differed significantly from each other, for each village and each morbidity category ($p < .05$ for one test, $p < .01$ for the other seven).

d. Differences Between Average Seasonal Morbidity. The seasonal average morbidity rates differed significantly from each other for both villages and all disease categories ($p < .01$ for all tests).

e. Wet Versus Dry Season Morbidity. There was no significant difference in morbidity rates between the wet and dry seasons for skin infections or respiratory diseases in either village. For infectious diseases and diarrhea, morbidity rates were significantly higher during the wet season than during the dry, in both villages ($p < .05$ in all four cases).

3. Results for Interactions Between Village and Other Factors

The extent to which the estimates of the effects previously defined differed between the two communities was assessed. This was done by defining and estimating a series of interaction secondary parameters. For example, to estimate the difference between Florida Aceituno and Guanagazapa of the effect of longitudinal sample membership on diarrheal

morbidity, the estimate of the longitudinal sample parameter in Florida Aceituno (2.9) was subtracted from the estimate in Guanagazapa (2.2), giving a difference of - .7 ± 3.8 (which is not significant). Thus, it was concluded that the effect of longitudinal sample membership was not different in the two villages. Analogous interaction parameters were defined based on most of the primary and secondary parameters. In each case, those parameters (and the associated tests) address the issue of whether or not the effect of the factor being considered was different in the two villages. The majority of these effects turned out to be slight (i.e., non-significant). The two exceptions were the village by family size parameters and village by time parameters.

The overall tests of the family size by village parameters were significant for skin infections, respiratory diseases, and diarrhea ($p < .01$ in each case). While this demonstrates that family size had different effects on these morbidity categories in the two villages, comparison of the FA and GU family size parameter estimates in Tables IV.12, IV.22 and IV.23 reveals no systematic pattern to these differences. The overall tests of the month by village interactions were significant for respiratory diseases, infectious diseases, and diarrhea (all $p < .01$). Unfortunately, there is again no discernable pattern in the differential effects of time in the two villages.

4. Correlations Among Types of Morbidity

The correlations among the four classes of morbidity, adjusted for all sources of variation in the model, are shown in Table IV.24. The correlations are shown separately by community. Since each correlation matrix was based upon more than 7000 degrees of freedom, it can be firmly concluded that the four types of morbidity were uncorrelated, on a within-

TABLE IV.24

Correlations Among Four Classes of Morbidity
Adjusted For All Variables In the Model By Community

A. Florida Aceituno

Morbidity Class	Skin Infections	Respiratory Disease	Infectious Disease	Diarrhea
Skin Infections	1	-0.022	-0.001	-0.016
Respiratory Disease	-0.022	1	0.007	0.009
Infectious Disease	-0.001	0.007	1	0.023
Diarrhea	-0.016	0.009	0.023	1

B. Guanagazapa

Morbidity Class	Skin Infections	Respiratory Disease	Infectious Disease	Diarrhea
Skin Infections	1	-0.005	-0.010	0.023
Respiratory Disease	-0.005	1	0.009	0.017
Infectious Disease	-0.010	0.009	1	0.014
Diarrhea	0.023	0.017	0.014	1

family basis, in both communities. Note that these correlations have had the effects of month-to-month (and other sources of) variations removed. If raw correlations were computed, ignoring the effects of month-to-month variability and other known sources of variation included in these models, non-zero correlations which would reflect temporal variation in mean morbidity rates would be seen. Such non-zero correlations would not indicate underlying associations between diseases or conditions in the four classes analyzed here.

Summary

These results make it clear that the four types of morbidity are extremely variable. In addition, the monthly family morbidity rates are preponderantly zero. These two features of the data tend to make analyses of the effect of various variables on morbidity difficult. Other than time, family size was the only other factor shown to produce substantial effects. The large families have disproportionately high morbidity rates. No substantial morbidity effects were found to be associated with sanitary conditions, water source, water quantity used or longitudinal sample membership.

Other Morbidity -- Sanitation Analyses

These analyses were based upon family monthly morbidity rates. That is, rates were computed for each family each month. The analyses do not take variability into account in morbidity rates among the various age groups within a family nor possible morbidity-sex relationships. In addition, since rates were computed monthly, a large proportion of the data values were zeroes (no morbidity in that class for family within a given month).

A second series of linear model analyses were performed separately for subjects in different age groups which are defined in Table IV.25. These analyses were performed using morbidity rates accumulated over six-month seasons. The definition of "seasons" is given in Table IV.26.

TABLE IV.25

Age Groups Used in Model Analyses

Age group Mnemonic	Definition
AGE00_01	Age < 365 days
AGE01_02	365 ≤ Age < 2 years
AGE02_07	2 years ≤ Age < 7 years
AGE07_15	7 years ≤ Age < 15 years
AGE15_30	15 years ≤ Age < 30 years
AGE30_45	30 years ≤ Age < 45 years
AGE45+	Age ≥ 45 years

TABLE IV.26

Definition of Seasons Used in Analyses

Type of Season	Month	Year			
		'73-'74	'74-'75	'75-'76	'76
	May	1	3	5	7
	Jun	1	3	5	7
	July	1	3	5	7
Rainy	Aug	1	3	5	7
	Sep	1	3	5	—
	Oct	—	3	5	—
	Nov	2	4	6	—
	Dec	—	—	—	—
Dry	Jan	2	4	6	—
	Feb	—	4	6	—
	Mar	2	4	6	—
	Apr	2	4	6	—

Season Number

NOTE: A dash (—) indicates that no morbidity data were collected in the indicated month.

A morbidity rate was then computed for each age-sex group in each family for each season:

$$\text{Morbidity rate} = 1000 \times \frac{\text{number of morbid incidents in this age-sex group in this family during this season}}{\text{total number of person-months in this age-sex group in this family in this season}}$$

A "person-month" is one person in one month. Thus, one person in an age group present for six months of a season would equal 6 person-months. No rates were computed for cases in which the denominator would be zero.

Since a family was sometimes surveyed for sanitary status several times in a season, the average of all surveys of the sanitation variable (e.g., CCOVER) was computed in order to assign sanitation scores. These sanitation scores, based upon the average, were:

0.5 ≤ average:	score = '+'
average ≤ 0.5:	score = '.'
no data this season:	score = (missing).

Since sanitation variables were assigned a '1' connoting a "positive" or "good" response and a '0' connoting a "negative" response, families having at least half of their responses in a season being "good" received '+' scores.

A variety of general linear models analyses were performed to examine the data for possible sanitation status-morbidity relationships. More than a thousand model fittings produced no persistent (over age groups or community groups) significant relationships between any of the sanitary variables and any of the morbidity rates. Statistically significant results were found at approximately the rate to be expected (5%) if all null hypotheses (H_0: no correlation between sanitary status and

morbidity) were false. Where statistically significant associations were found, examination of appropriate data plots indicated little or no real significance of the result. Figure IV.20 is the printout of one of the more than 1000 general linear models analyses performed. The other thousand or so figures are omitted.

In addition to the linear models analyses, morbidity rates were computed for each group defined by age, sex, season, village and family seasonal score for a sanitary variable (e.g., '+' or '-' for 'CCOVER' for whether the water container was covered). Some nine hundred graphs, such as Figure IV.21, were produced to examine the data for possible differences between morbidity for families with good sanitation scores and families with poor sanitation scores. Extensive examination of such graphs and comparison with the corresponding linear models analyses failed to produce strong evidence of persistent morbidity-sanitation relationships.

Another form of graphical analysis was performed in which morbidity rates were computed for each community, month, and age group. The proportion of families having "positive" scores on a sanitation variable was also computed by community and month. More than one thousand scatter diagrams, such as Figure IV.22, were produced to illustrate possible sanitation-morbidity associations. Extensive examination of the scatter diagrams and comparison with the corresponding linear models analyses failed to produce strong evidence of persistent sanitation-morbidity relationships.

Conclusions

It can not be reasonably concluded from these results that there is no association between sanitation and morbidity since the higher death rate from infectious diseases in the developing countries is clearly demonstrable. The issue here is whether, in a free-living population in lowland Guatemala, the

FIGURE IV.20

Linear Model Analysis of Relationship Between Morbidity and Sanitation
(Sample Printout)

MODEL OF MORBIDITY RATES USING SEASONAL MEANS 17:20 TUESDAY, JANUARY 18, 1978 318
AGE CATEGORY IN YEARS-AGE02-07 SANITARY VARIABLE-COOLING

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RESPRATE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	32	[illegible]	[illegible]	3.71	0.0007	0.831668	91.5903
ERROR	24	[illegible]	[illegible]		STD DEV		RESPRATE MEAN
UNCORRECTED TOTAL	56	[illegible]			61.41263029		67.077486229

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VILLIAGE	1	[illegible]	0.26	0.5987
SEX.AGE	1	[illegible]	0.25	0.6197
SEX.SEX	1	[illegible]	1.87	0.0009
[illegible]	7	[illegible]	2.28	0.0030
VILLIAGE*SEXIND	1	[illegible]	1.15	0.2938
VILLIAGE*SAGCON	1	[illegible]	0.06	0.8047
VILLIAGE*SEASON	6	[illegible]	1.71	0.1205
SEX*SAGCON	1	[illegible]	0.61	0.4438
SEX*SEASON	6	[illegible]	0.91	0.1067
SAGCON*SEASON	6	[illegible]	1.07	0.4066
VILLIAGE*SEX*SAGCON	1	[illegible]	0.03	0.8552

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VILLIAGE		[illegible] B	-1.20	0.2147	53.90314574
SEX.AGE		[illegible] B	-0.85	0.4044	53.90314574
SEX.SEX		[illegible] B	-2.11	0.0355	53.90314574
SEASON	1	[illegible]	0.59	0.5603	46.42354488
	2	[illegible]	0.59	0.5634	46.42354488
	3	[illegible]	1.49	0.1353	46.42354488
	4	[illegible]	2.42	0.0237	46.42354488
	5	[illegible]	2.15	0.0418	46.42354488
	6	[illegible]	1.84	0.1741	46.42354488
	7	[illegible]	2.83	0.0093	46.42354488
VILLIAGE*SEXIND		[illegible]	1.07	0.2928	46.42354488
VILLIAGE*SAGCON		[illegible]	0.25	0.8057	46.42354488
VILLIAGE*SEASON	1	[illegible] B	0.82	0.3208	61.41263029
	2	[illegible] B	1.70	0.1013	61.41263029
	3	[illegible] B	0.92	0.3613	61.41263029
	4	[illegible] B	1.36	0.1814	61.41263029
	5	[illegible] B	0.64	0.5287	61.41263029
	6	[illegible] B	1.95	0.0627	61.41263029
	7	[illegible] B	.	.	61.41263029
SEX*SAGCON		[illegible]	0.78	0.4436	46.42354488
SEX*SEASON	1	[illegible] B	0.32	0.7499	61.41263029
	2	[illegible] B	0.52	0.6105	61.41263029
	3	[illegible] B	0.70	0.4903	61.41263029
	4	[illegible] B	1.17	[illegible]	61.41263029

FIGURE IV.20 CONT'D

Linear Model Analysis of Relationship Between Morbidity and Sanitation
(Sample Printout)

[illegible] 17:30 THURSDAY, JANUARY [illegible], 1978 [illegible]

AGE CALCULATED IN YEARS-AGEOUT-07 [illegible] VARIABLE-CCCLEND

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RESPRATE

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
	5	[illegible] B	0.22	0.8274	61.41263029
	6	[illegible] B	-0.05	0.9663	61.41263029
	7	[illegible] B	.	.	.
SANLOW*SEASON	1	[illegible] B	1.28	0.2120	61.41263029
	2	[illegible] B	1.89	0.0744	61.41263029
	3	[illegible] B	0.08	0.9392	61.41263029
	4	[illegible] B	0.07	0.9451	61.41263029
	5	[illegible] B	1.12	0.2738	61.41263029
	6	[illegible] B	0.67	0.5100	61.41263029
	7	[illegible] B	.	.	.
VILLIN*SEXEND*ABCOD		[illegible]	-0.16	0.6652	[illegible]

FIGURE IV.21

Diarrheal Morbidity In Families With Good (+) and Poor (-) Sanitation
(Sample Graph)

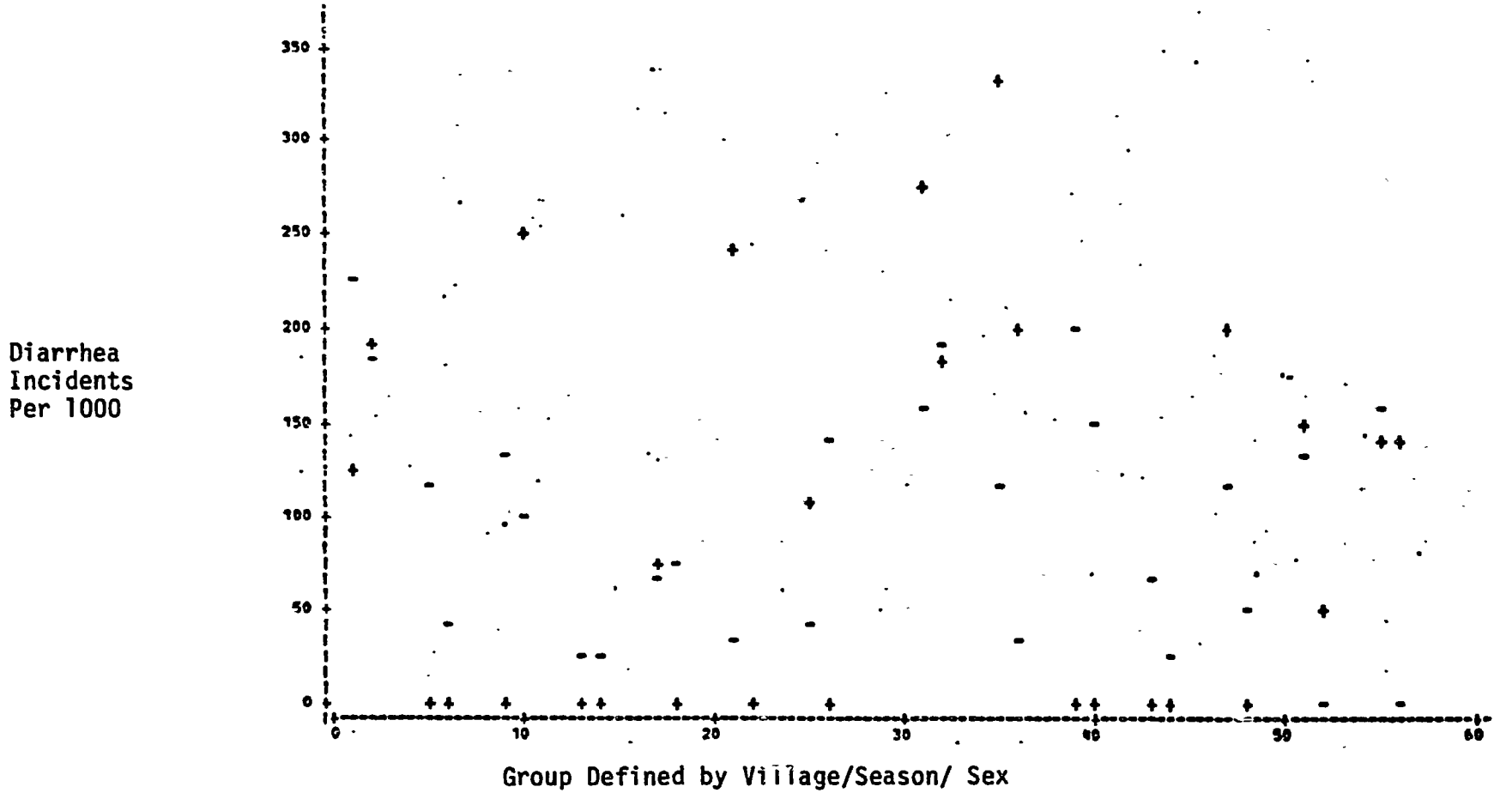
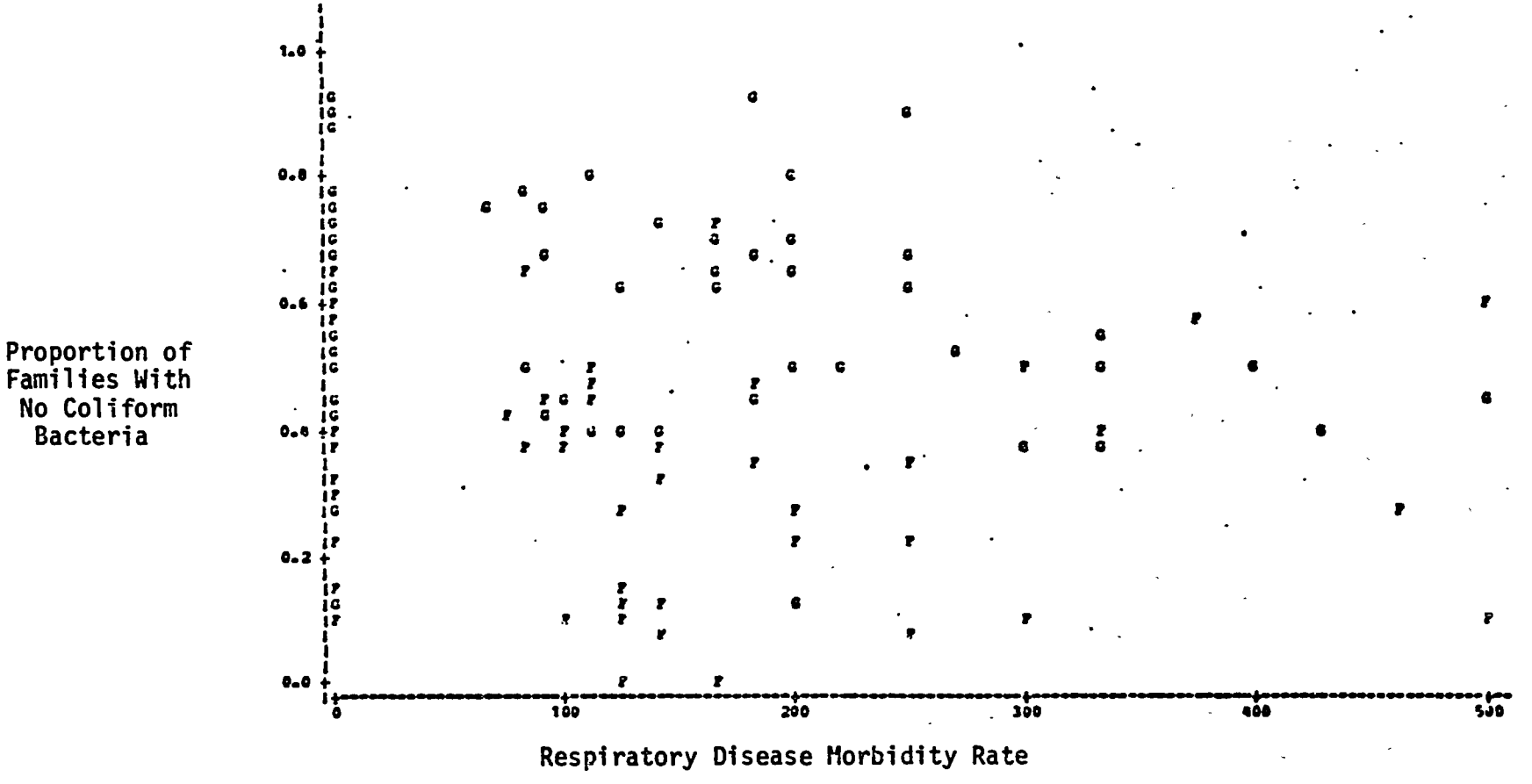


FIGURE IV.22

Comparison of Respiratory Morbidity and Water Quality
in Domestic Containers in Both Villages
(Sample Graph)



minor variations in sanitary conditions (which are measurable using surveys such as the ones used in this study) produce macro-level changes in morbidity which are measurable by a two-week recall method, as used in this study. The conclusion is that the relationships between morbidity and sanitation may not exist at this macro level. If they do exist, they are too small to be reliably measured by the instruments and with the sample sizes used in this study.

V. Health Education

The objective of the health education program was to reduce fecal contamination in the home and surrounding area and to promote adequate use of the convenient potable water system. The program was conducted only in the experimental village. This component of the study focused on:

1. Persuading the residents of Guanagazapa to reduce the presence of both human and animal fecal wastes in the home and the yard.

2. Assisting families to install gates to keep domestic animals out of the kitchen.

3. The promotion of latrines and assisting families in building latrines with an objective of reducing contamination from human excrement.

4. Improving food and water storage practices to reduce contamination from human, animal, insect and air-borne sources.

5. Increasing potable water consumption for hygienic uses, particularly in kitchen cleanliness, handwashing before eating or preparing food, and after defecating or changing soiled diapers.

The education program took a community health development approach to stimulating change in behavior. This program is described in the Methodology section of this report and includes descriptions of the field procedures and details of the survey instruments.

Behavioral Changes

In order to examine the change in sanitary behavior over time, the study was divided into two phases. One covering the time period prior to the initiation of the health education component in Guanagazapa (the period prior to April 1975) and the other consisting of those months after the initiation of the health education program (from May

1975 to the end of the study). The means from the measurement of environmental variables were computed for each family from the monthly sanitation survey (Form 32) for both phases of the study. In all, ten variables were analyzed. Using the means of these as the dependent variables, a linear model (2x2 factorial) analysis was performed for each of the ten variables.

Statistical Analysis

Using the model, the pre- and post program means were estimated for each sanitary behavior variable studied. These estimates, with their associated standard errors, are presented in Table V.1.

From these estimates, secondary parameters (effect of community, effect of time, community by time interaction) were defined, estimated and tested for significance. The main effect of community is the difference between the means of the two villages averaged over the two time periods. The main effect of time is the difference between the pre- and post-program means averaged over the two communities. The interaction effect is the difference between Guanagazapa's improvement, if any, from the pre-program to the post-program period and Florida Aceituno's pre- to post-period improvement, if any. This estimate represents the difference in trends over time in the two villages.

Results

The results of twenty seven significance tests are summarized in Table V.2. All tests were two-tailed (i.e., no directional hypotheses were prespecified). In interpreting these results, a decrease in mean for three of the variables (garbage on the kitchen floor, cleanliness of the kitchen floor, garbage in the yard) indicates improvement while such a decrease is retrogressive in the other seven variables.

TABLE V.1

Program Means of Observed Sanitary Behavior in the Home

	Florida Aceituno				Guanagazapa			
	Pre-Program		Post-Program		Pre-Program		Post-Program	
Variable Description	Mean	S.E.*	Mean	S.E.	Mean	S.E.	Mean	S.E.
Family Clothing	1.010	.032	0.993	.034	0.902	.031	0.886	.033
Informants Clothing	1.080	.031	1.150	.033	1.050	.031	9.975	.032
Fecal matter Kit. floor	0.465	.021	0.613	.021	0.386	.021	0.222	.021
Garbage on Kit. floor	0.688	.020	0.482	.023	0.738	.020	0.560	.023
Cooked food Covered	0.528	.021	0.441	.022	0.592	.021	0.760	.021
Garbage in Yard	0.771	.020	0.444	.022	0.704	.019	0.329	.022
Water Cont. Covered	0.778	.040	0.536	.040	1.190	.040	1.480	.039
Informants Shoes	0.358	.025	0.445	.024	0.580	.025	0.619	.025
Yard swept Recently	0.369	.021	0.338	.019	0.347	.021	0.670	.019
Latrine Clean	0.470	.045	0.497	.050	0.479	.036	0.589	.039

*Standard error

TABLE V.2

Hypothesis Testing for Sanitation Variables

Variable	Main Effect of Community		Main Effect of Time		Interaction Effect Community x Time	
	Sig.	Direction	Sig.	Direction	Sig.	Direction
Family clothing	$p<.01$	$\bar{F}>\bar{G}$	$p>.05$	$\bar{T}_1\approx\bar{T}_2$	$p>.05$	$(G_2-F_2)\approx(G_1-F_1)$
Informants clothing	$p<.05$	$\bar{F}>\bar{G}$	$p>.05$	$\bar{T}_1\approx\bar{T}_2$	$p<.01$	$(F_2-G_2)>(F_1-G_1)$
Fecal matter kitchen floor	$p<.01$	$\bar{F}>\bar{G}$	$p>.05$	$\bar{T}_1\approx\bar{T}_2$	$p<.01$	$(F_2-G_2)>(F_1-G_1)$
Garbage on kitchen floor	$p<.05$	$\bar{G}>\bar{F}$	$p<.01$	$\bar{T}_1>\bar{T}_2$	$p>.05$	$(F_2-G_2)\approx(F_1-G_1)$
Cooked food covered	$p<.01$	$\bar{G}>\bar{F}$	$p<.01$	$\bar{T}_2>\bar{T}_1$	$p<.01$	$(G_2-F_2)>(G_1-F_1)$
Garbage in yard	$p<.01$	$\bar{F}>\bar{G}$	$p<.01$	$\bar{T}_2>\bar{T}_1$	$p>.05$	$(G_2-F_2)\approx(G_1-F_1)$
Water container covered	$p<.01$	$\bar{G}>\bar{F}$	$p>.05$	$\bar{T}_2>\bar{T}_1$	$p<.01$	$(G_2-F_2)>(G_1-F_1)$
Yard swept	$p<.01$	$\bar{G}>\bar{F}$	$p<.01$	$\bar{T}_2>\bar{T}_1$	$p<.01$	$(G_2-F_2)>(G_1-F_1)$
Informants shoes	$p<.01$	$\bar{G}>\bar{F}$	$p<.01$	$\bar{T}_2>\bar{T}_1$	$p>.05$	$(G_2-F_2)\approx(G_1-F_1)$

F=Florida Aceituno
G=Guanagazapa
— = Mean

T_1=Period before education program

T_2=Period after start of program

For the variable which measured the interviewer's rating of the cleanliness of family clothing, families in Florida Aceituno were rated significantly cleaner and both villages were rated significantly cleaner in the period preceeding the start of the sanitation education program. There was no evidence that the health education program had any desirable effect on this variable.

The interviewer's rating of the cleanliness of the clothing worn by the informant (rather than the family as a whole), showed Florida Aceituno, once again, to be significantly cleaner than Guanagazapa. The average trend in time was not significant, nor was the interaction of community over time. It was anitcipated that the availability of abundant convenient, potable water in Guanagazapa would result in an observable difference in the cleanliness of the clothing of the female head-of-house (the usual informant). However, this did not occur. The introduction of piped water in Guanagazapa was followed by a number of changes in the method of clothes washing. Previously, clothing had been washed on rocks in the river, or at a communal pila which consisted of a number of concrete wash sinks filled from a common water reservoir. Clothes washing was a social opportunity for women in the villages. Based on observation, clothes were washed with greater frequency in the home after introduction of water. Many families purchased individual wash sinks and connected them to the water system. Women reported that, while they generally washed clothing more frequently, they washed smaller quantities. Therefore, with increased water availability, women did not wear clean clothing more often. Clothes washing was an all-day chore before the introduction of water. Afterwards, washing was done two or three times per week, requiring less time on any given day but

not impacting in a noticeable way on the appearance of the family clothing.

For the variable describing the presence of animal or human fecal matter on the floor, Guanagazapa had significantly lower means (desirable for this variable). There was no significant average trend over time, but there was a significant time and community interaction. This was due to the fact that, while conditions improved over time in Guanagazapa, they got worse in Florida Aceituno. This pattern suggests that the program did influence families in Guanagazapa to prevent or to remove fecal matter contaminating their floors.

Reduction of fecal matter in the home environment was accomplished in a variety of ways including introduction of latrines and building of animal barriers. In addition, it seems unlikely that this reduction would have occurred if families had not become more sanitation conscious in their behavior. The fact that the control community (Florida Aceituno) got worse over time while Guanagazapa got better suggests that the program intervention had an impact.

Guanagazapa had a significantly higher mea than Florida Aceituno, averaged over time, for the variable which indicated whether or not cooked food was kept covered. While Florida Aceituno got worse over time, Guanagazapa improved. Thus, the average trend was an improvement in the protection of cooked food. The time by community interaction was, therefore significant and supports the conclusion that the desired behavioral change did occur.

The education program presented to women consistently stressed kitchen hygiene and the importance of keeping food and water in clean, covered containers. Women's programs were well attended and the interests of participants were continually appraised in order to match programming

with these interests. Cooking was of great interest. Cooking courses which provided new receipes and integrated demonstrations on handwashing, hygienic food and water storage were extremely well received. Women took pride in their cooking, even though their means were very limited. Program implementation allowed for group cooking and the practice of the new behaviors while building on the existing cultural mores.

Guanagazapa had a significantly higher average score (over time) on K_CONTCV, a variable which indicated whether or not water containers were kept covered. There was no significant trend in time (averaged over the two communities). However, change came about because Florida Aceituno was getting worse over time while Guanagazapa got better, leaving the average roughly unchanged. The intereaction of community over time was significant. Water, stored in the kitchen, was used for drinking, cooking, and handwashing. Potable water was available throughout the pre-educational period. However,it was not until after the program was in operation that the hygienic storage of water took place.

In the case of the surveyor's observation of whether or not the yard was swept, a crossover pattern was observed. In the pre-program period, Florida Aceituno was slightly better than Guanagazapa. In the post-program phase, however, Florida got worse, while Guanagazapa got much better and finished with a mean nearly twice as high as that for Florida. This interaction effect was clear and resulted in a significant effect of increase over time and a significant community effect with Guangazapa higher than Florida Aceituno. It was demonstrated that families in Guanagazapa did improve the environment around their homes during the study period.

The presence of garbage in the patio was also observed during

monthly surveys. Guanagazapa had a lower mean, averaged over time, for this variable. The number of times garbage was observed on the ground surrounding the house decreased significantly over time, averaged over the two communities. There was no significant interaction effect. Although Guanagazapa was considerably cleaner than Florida Aceituno at the end of the study, the results of this analysis do not suggest that this was due to the sanitary education program since improvement was also seen in the control community.

The presence of garbage or refuse on the floor of the kitchen was noted on the survey forms. On the average, kitchen floors were cleaner in Florida Aceituno than in Guanagazapa. Even though the sanitary condition of kitchen floors did improve in Guanagazapa over the period of the study, Florida followed the same pattern. This improvement in garbage disposal on the kitchen floor cannot be attributed to the education program in Guanagazapa.

Garbage thrown on the floor in the kitchen and on the ground outside the house was not uncommon in both villages since food wastes were often fed to domestic animals in this way. Actually this garbage was quickly consumed. Non-edible refuse was occasionally burned or buried but usually it was dumped on the fringes of the property.

No attempt was made in the educational program to encourage behavioral changes in the use of shoes. However, during the monthly surveys, interviewers noted whether the informant was wearing shoes. This data demonstrates that the practice of wearing shoes, particularly by the female head-of-household, was seen more frequently in both villages at the end of the study. Since no educational effort was made for this variable, the change suggests a developmental improvement in family

living standards.

Attitude Changes

The assumption underlying the health education program was that more and more families in Guanagazapa would acquire new perceptions of sanitation and change existing attitudes to follow those advocated in the sanitary education program.

Longitudinal sample families were interviewed a total of six times, three in 1975 and three in 1976. A multivariate linear model was fit separately for each variable on Form 41 (Assessment of Attitudes and Perceptions).* The six scores for a family over time were treated as six dependent variables, thus time was considered as a within-subject factor. The community was treated as the between-subject factor in the analysis. Conventional main effect and interaction parameters were estimated and the corresponding hypotheses were tested. The following tests were performed: (a) an examination of the difference between the two communities averaged over time; (b) the difference between the time periods averaged over the two communities; (c) the difference between the trend with time in one community and the trend with time in the other. Scores in Guanagazapa were expected to increase more rapidly than in Florida Aceituno as a result of the education program.

Many of the changes in behavior related directly to the cultural role of women. The data collected from the female head-of-household was considered the most sensitive indicator reflecting attitudinal changes in the family. However, no single response or perception could accurately reflect the attitude of a family toward a wide range of sanitary improvements. A series of questions, covering a number of dimensions, were used

*See Methodology Report

and then summarized using a weighted scale.

The responses were ranked so that the highest score would reflect those attitudes conforming to the goals of the program. The lowest score reflected a negative or indifferent perception. These scores were weighted and then added to produce a health education scale. The variables were not weighted equally. Those considered more significant were the perceived difference between the quality of potable and nonpotable water, attitudes relating to the disposal of human feces, the perceived health implications of domestic animals and flies in the kitchen, knowledge concerning the causes of diarrhea in children, and the family's perception of the relationship of personal hygiene and disease. These variables were given more weight. Other variables, given less weight, were knowledge of the cause of diarrhea in adults, knowledge of the germ theory, reasons for handwashing and bathing by family members, and the use of soap in the house.

Together, these weighted variables formed a summed health education scale. A sanitation perception scale was computed for the longitudinal population sample for both Florida Aceituno and for Guanagazapa. There were three tests in 1975 and three tests in 1976 at approximately equal intervals. Each community was surveyed during the same months. The first data point represents a baseline before the start of the educational program. Table V.3 shows the changes which occurred in the weighted means of health behavior and perception variables over time as measured by the health education scale.

TABLE V.3

Perception Scale Over Time

Community	1975 T1*	1975 T2	1975 T3	1976 T1	1976 T2	1976 T3
Florida Aceituno	182.7	210.7	204.7	213.7	219.4	219.3
Guanagazapa	185.7	232.2	238.9	274.4	262.9	268.3

*Prior to health education program.

Based on this scale which represents changes in perception but not necessarily in behavior; the community main effects, the time main effects, and the community-time interaction effects were all significantly different at $p<.001$.

Since the health education population sample was considered representative of each village, the conclusion can be drawn that this program clearly reached the residents of the experimental village and influenced their attitudes relating to the sanitation changes. Whether these changes in attitude and perception will become permanent is not known.

Water Uses

Although it was anticipated that Guanagazapa families would bath more frequently given a ready supply of available water, no significant differences were reported in the year following the introduction of the health education program. In both communities, women reported bathing eleven times per month on the average.

The change in perceptions of Guanagazapa women with regard to differences between tap water and river water was significant. Guanagazapa residents

generally described potable water as cleaner and recognized that it was treated,while non-potable water was described as dirty and could carry disease. In Florida Aceituno, the benefits of treated water were not as frequently associated with cleanliness or healthfulness. People did not distinguish between well water, river water and tap water.

These perceptions on water use, although different in the two communities, were not noticeably translated into behavior change over the time period measured. The data compares perceptions only between 1975 and 1976,which is a very short period for behavioral changes to occur.

Cultural mores on bathing and handwashing included the belief that bathing while menstruating, ill, or lactating had deleterious health effects. In the latter case, water was thought to "chill" the mother's milk, making her and the infant more prone to diseases. Menstruation and pregnancy were considered to place the body in a "hot" state. The shock of cold water to this person was considered harmful. Men, returning from work in the fields who had perspired and whose hands were "hot" from working, believed that the chill of handwashing would cause arthritic or rheumatic symptoms to appear. The educational program did not attempt to change these widespread beliefs. The emphasis was on behavioral rather than cultural change. Thus, the change in the health belief system was not so much marked by the replacement of old beliefs with new ones,but by providing additional modern explanations for the behavioral changes being advocated through the health education program.

Guanagazapa residents reported poorer handwashing behavior than did Florida Aceituno at the start of the study. While both communities showed significant improvements over time, Guanagazapa' change was dramatic and the interaction effect was statistically significant. This suggests that

improved handwashing in the experimental community was produced as a result of the educational program.

The program placed emphasis on the need for handwashing,using soap in addition to water. The village perception of handwashing was "any contact with water". The program sought to improve handwashing methods, frequency, and the use of soap. Field surveyors asked the female head-of-household to recall when she normally washed her hands during the course of a day. The frequency and purpose for each handwashing was then recorded.

The reasons for handwashing were analyzed and handwashing before food handling and handwashing after defecating or urinating showed a significant community by time interaction effect. These findings further support the conclusion that program efforts did change hygienic behavior, particularly those most closely linked to fecal-oral contamination.

Latrinization

A 1972 housing survey showed that 32% (66) of the households in Guanagazapa reported having a latrine although no visual inspection was made. Observations made later indicated that usage varied and that many families failed to use the latrines they owned. A Community Betterment Committee was formed to set guidelines for the introduction, sale and control of latrines. The guidelines, discussed in the Methodology Report, were designed to encourage optimal usage by the family and to overcome difficulties encountered in a previous program to encourage latrine construction some seven years prior to the current study.

During the period between May 1975 and the close of the field program in the summer of 1976, seventy-nine new latrines were installed in Guanagazapa. This result is significant since almost no construction of latrines was seen in Florida Aceituno during this period. Seventeen of

the new latrines were constructed at homes which already had latrines. The old latrines were either in a state of disrepair or otherwise unacceptable to the family.

Latrinization is a difficult innovation to introduce, particularly among population groups whose previous custom is to defecate by squatting. Latrines were made available for village houses in Guanagazapa by the Guatamalan government. Utilization required, in addition to a change in behavior, physiological changes in the use of abdominal muscles. This factor complicated the change effort needed to accustom the family to this innovation.

Eighty-two percent of all latrine construction occurred in houses with water connections in the patio. This linkage between sanitation improvements implies a directional change which can be related to the health education program. Eighteen percent of the latrines served two or more families, however most latrines were used by members of a single household. Generally, latrines were well maintained once they were constructed.

The building of a latrine represented a special effort by the family. The cost of construction varied between $1 and $30 depending on the materials and labor source the family used. However, the majority of families (68.5%) spent under $2.00. In order to limit the cash outlay, the pit was usually dug by the male head-of-household and the building was constructed from materials which were free or inexpensive and readily available. Scrap wood, cane and bamboo were the most common wall materials and tin was usually used for the roof.

Thirty-nine latrines were installed during the months of November and December 1975. This effort followed a community program, led by the Village Betterment Committee composed of local men, to organize groups

of families throughout the village for six informal discussion sessions regarding sanitary innovations in the home. Two of these sessions were devoted to the subject of latrines. One session concerned construction and included a visit to a latrine already installed by a local family and another was devoted to cleaning, usage and maintenance of the latrine. These meetings were held during October and November,at the end of the rainy season. This season appeared to be the best time to construct latrines. Soil conditions were ideal and village men had the time to provide the necessary labor. A similar promotional effort the following spring, at the height of the dry season, was disappointing. Even a sound promotional program could not encourage the men to construct latrines during the dry season when the soil became rock hard after months of no rainfall.

In November 1976, after the field program ended, latrines continued to be installed at a rate of about two per month.

The sanitary inspector re-visited homes with latrines during 1977 to ascertain usage. This was after the program terminated. The Betterment Committee had assumed responsibility for the distribution of latrine materials during this period. Families continued to request latrines with a slow but steady rate of adoption. Visual inspection and discussion with families by the inspector confirmed that latrines built during the educational program were still being used and were adequately maintained. Only one family had stopped using their latrine.

No significant differences in the perception of latrine usefulness was found between those families in Guanagazapa who built latrines and those who did not,as determined by attitude surveys. However, the guidelines for the latrine program as described in the Methodology Report required that the family make a considerable time investment in digging

the pit before a latrine could be obtained. Based on informal discussions with families the effort expended before installation was important because it helped insure a committment for usage. The male head-of-household usually spent three to five days in excavating the pit and latrines could not be purchased until the excavation was complete. The factor that differentiated those who were willing to provide funds and labor for a latrine from the unwilling is not identifiable from the surveys.

The principal promotional effort that preceded the sharp rise in latrine construction during November and December 1975 was done by selected villagers. Many of these had recently installed latrines for their households. These local men and their families could discuss the advantages and difficulties they encountered in building and using a latrine from their own experience. Although many villagers were aware of the fact that latrines were available, it was not until after recommendations by neighbors and an opportunity to visit an installation that many families adopted this improvement.

Animal Barriers

The most commonly owned domestic animals (dogs, pigs, chickens) were kept in the house or in the yard. Many homes consisted of a single room and no attempt was usually made to keep the animals out of the kitchen segment. The sanitary education program promoted the construction of barriers to prevent the entrance of animals.

Pigs were considered a source of ready cash and financial security to the family rather than a source of food. A piglet could be purchased at little expense, and with care and minimal feeding it could later be sold for ready cash. Women and children were responsible for the care of the pigs. In a tropical climate such care required close attention

since pigs can easily become overheated and die from heat exhaustion. Thus, pigs were not allowed out of sight for very long. During the mid-afternoon, it was common for them to be sheltered from the sun inside the house. Pigs were allowed to roam the yard and scavange for food. Building pig pens would have been expensive and would have necessitated feeding them and removing fecal material. Thus, pig pens were not considered as a practical alternative.

Chickens were kept for a ready source of eggs and were later sold rather than being eaten by the owner. They were also allowed to scavange in the yard and in the house and were often seen on food preparation surfaces and eating tables.

There was a belief by some villagers that animals that were put in a pen were more susceptible to disease. However, there were no cultural mores against barring them from kitchen areas. The design for kitchen barriers called for inexpensive materials such as cane or small branches. These could be secured to the door frame with nails and a piece of rubber cut from innertubes.

In Guanagazapa, forty-eight households built these animal barriers between June 1975 and the end of the field study. This was highly significant since virtually no barriers were installed in the control village during the same period. Data collected from the two communities showed differences in the perception of the harm associated with the presence of domestic animals in the house. Ten percent of the families in Florida Aceituno saw no risks associated with the presence of domestic animals while less than two percent of the families in Guanagazapa felt this way. Although there was no significant measurable change in this perception over time in Guanagazapa, the installation of animal barriers suggests

a greater readiness to initiate new behaviors.

Community Participation

Family participation in all activities related to the health education program was measured. Attendance at group sessions and hours of participation by each family were recorded. Two hundred and five families in Guanagazapa participated at least once in a planned program. The hours of attendance for these families ranged from one to two hundred sixty with an average of thirty-seven contact hours for each participant family. The total number of contact hours with individuals in the community during the program was seven thousand five hundred and sixty two. This extensive contact was achieved through the use of group multiplier methods. In general, no more than two or three program sessions, requiring supervision by the field staff, were scheduled per week.

Regular sessions for women met once per week in the afternoon for about two hours. Forty to fifty women were usually present. A total of three thousand one hundred and eighty-six contact hours or 42% of the total effort was directed to women. The men's Betterment Committee met once per week for two to three hours in the evening, except during the two month period when they were preparing for the community extension project. This latter project involved two sessions per week of about three hours and was attended by a core group of some thirty men. A total of three thousand five hundred and nine contact hours or 46% of the total hours were directed to men in the community. The same men's group organized additional meetings in the community to discuss sanitation methods. Each team invited from five to ten families to participate in six two-hour sessions. Some eight hundred and sixty-seven contact hours (11%) of the total program effort were completely organized and carried out by these village groups.

The field team responsible for health education consisted of two women with a high school education and the part-time support from the health post physician. A Sanitary Inspector helped with latrine installation and group sessions for men. Nurses from the health post were integrated into special activities such as midwifery training. A Health Education Consultant was responsible for the overall program design and operation.

Group methods as opposed to individual contacts or home visits were observed to be more effective because: (1) group methods allowed for greater participation by community members without increasing staffing requirements. Rather than spending one hour visiting one family, the staff could meet with a group of twenty to thirty persons at the same time; and (2) group methods seemed to encourage the assumption of family responsibility for changes. Group methods serve to increase peer pressure and mutual support for change. Where the potential for behavioral change was likely to be difficult, as in the construction of latrines or animal barriers, families became aware of the problems through discussion before trying the innovation. Thus, their actual experience in trying the new behavior matched their expectations. Difficulties encountered were not a surprise. Families, listening to peers discuss their experience, seemed more prepared to deal with problems and accept them as part of the adaptive process.

Relationship of Participation to Change

The relationship between behavior change and attitudes was examined. Specific behaviors such as the covering of food, the covering of water containers, keeping fecal matter off the floor, sweeping the yard, making a water connection, building an animal barrier, and installing a latrine, were analyzed. Although significant changes in the attitude of the community members can be attributed to the sanitary education program, the question

remains unanswered as to the connection between attitude and behavior change at the family level.

Pearson product moment correlation coefficients were computed to establish the association between the degree of family attitudinal change and the level of observed behavioral change. With two hundred and three observations, no singificant association was found. This seems to point to the independence of the two phenomena. It is clear that the program did produce attitude changes and behavior changes in the population of Guanagazapa. However, these two effects appear to be independent indicators of the program processes. At the family level, no association was observed to exist between attitude and behavioral change.

The behavioral scale was correlated with total hours of participation in the health education program, to determine the association between family participation and behavior change. The Pearson product moment correlation coefficient was 0.44. This is a highly significant association with a $p<.0001$. This finding is very important because it supports the value of the approach used in designing and implementing the program.

Summary

Emphasis was placed on group multiplier methods to increase the opportunity for community participation. Programing was designed to maximize villager involvement and minimize the number of required field personnel. An important part of the methodolgoy was that community needs and interests were considered in the program design whether or not they were directly related to health or sanitation. This was done to maintain interest and to attract as many participants as possible to some or all phases of the program.

The health education program was designed to change sanitation behavior

in order to maximize the benefits arising from the potable water system. Analysis of results indicates a marked program impact on the attitudes and behaviors of the experimental community. Significant differences were observed in the cleanliness of the yard surrounding the house and in food and water storage methods. Guanagazapa families adopted the practice of covering food and water containers to prevent contamination. Also, families became more vigilant with regard to the presence of fecal matter in the home. No significant change was noted in the cleanliness of family clothing or in the amount of garbage seen around the home. Handwashing practices did improve but the frequency of bathing did not change.

Attitudes toward health and sanitary improvements clearly changed in the experimental village as a result of the program. However, no association between attitudes and behavioral change was found. Participation by community members in the health education program was strongly associated with subsequent behavioral change.

VI. Digestibility Studies (Reference Population)

The human gastrointestinal tract is not one hundred percent efficient in digesting and absorbing food or in metabolizing the absorbed nutrients. It is necessary to take into account the extent to which the ingested food is digested and absorbed in order to determine the amount of energy made available to the body from a nutrient. The efficiency of digestion varies from one food to another. The relationship between the amount of nutrient in the ingested food to the amount of nutrient which is excreted in the feces is termed the coefficient of digestibility. This coefficient is a measure of the completeness of digestion and the difference between intake and output represents that portion of the ingested food which was digested and available to the body.

The diet regularly consumed by individuals living in the rural area of Guatemala (Pacific lowlands) is characterized by its high content of corn and beans and a minimal amount of food of animal origin. Information regarding the digestibility and biological value of this diet is fragmentary.

In order to obtain this information, studies were done on healthy soldiers who were designated as a "reference" group to whom other Guatemalan populations could be compared. These soldiers were all born in the Pacific lowlands of Guatemala and had been living, during the immediate eighteen months to two years prior to this study, at a military installation near Guatemala City. The level of environmental sanitation at the military post was higher and the diet quantitatively superior to that available to the rural population in the test and control villages.

1. Summary of Results

The data obtained from 13 of the soldier-subjects, who were hospitalized

during the full period of this study, is presented here in some detail. Statistical analysis indicated that the variability between the results of Balances 4 through 7 were less marked than that observed during the previous balance periods. This is interpreted as evidence that, during Balance 4 through 7, the subjects were maximally adapted to the rural metabolic corn and bean diet. The mean absorption values derived from these four balance periods were used as "normal intestinal absorption criteria" for calories, nitrogen and fat for young Guatemalan males. The values, using a hierarchal statistical analysis, were 92.3% absorption of calories, 85.6% absorption of nitrogen, and 86.0% absorption of fat.

After evaluating the distribution and behavior of absorption of the three components in the subjects studied, the lower third of the distribution curve, rather than the mean, was chosen as "normal". Therefore, 90.5% for the absorption of calories, 82.5% for the absorption of nitrogen, and 83.5% for the absorption of fat were selected.

2. Summary of Conclusions

a. This work represents the first study to evaluate the digestibility of a mixed diet containing large amounts of corn and beans such as the one regularly consumed in rural Guatemala.

b. The "values" derived from this study for the "normal" intestinal absorption of calories, nitrogen and fat for subjects on the rural Guatemalan diet are more realistic than those currently available from the literature. This literature is more applicable to North American and Western European diets.

c. The use of these values permits a scientific approach to evaluation of the efficiency of the gastrointestinal system of rural Guatemalans in regard to the absorption of a diet similar to that which

they regularly consume.

Detailed Assessment of Digestibility and Biological Value of a Mixed Corn-Bean Rural Guatemalan Diet

The principal objective of this digestibility study was to evaluate the capacity of the gastrointestinal tract of a "reference population" to absorb the 2,800 Calorie diet which was utilized at the rural metabolic ward for village subjects. A second objective was to determine values for obligatory nitrogen loss in this "reference population" while they were receiving an essentially nitrogen-free diet.

The results were used to provide an operational definition of absorption for comparison with subjects living in the lowlands of Guatemala. The experimental design permited an estimate of the variability of absorption and excretion of the components of this diet, including subject-to-subject variability and variability within-a-subject from one balance to another.

1. Experimental Design and Methodology

The reference population was a group of healthy Guatemalan males between 18 and 25 years of age with the same or similar ethnic and environmental backgrounds as the village subjects but who had been living under better sanitary conditions for two years prior to the study. Soldiers from the Guatemalan army, who were born in the Pacific lowlands of Guatemala, but had been living for the last 2 years at the "Mariscal Zavala" military post near Guatemala City met these criteria.

The protocol to study this reference population included three phases:

a. Phase I: Selection of the study subjects and specification of the Mariscal Zavala Diet (M.Z. Diet).

b. Phase II: Determination of the obligatory nitrogen fecal loss.

c. Phase III: Detailed absorption studies using the Rural Metabolic Diet.

Phases II and III were carried out in a 10-bed metabolic ward built at Mariscal Zavala Infirmary. Specially trained personnel, under the direction of a nutritionist, closely supervised the subjects during the studies.

Phase I: Selection of the study subjects and specification of the Mariscal Zavala Diet (M.Z. Diet)

1. Selection of the study subjects. One hundred soldiers between 18 and 25 years of age, born in the Pacific lowlands of Guatemala and who had lived for 18 months to 2 years at the Mariscal Zavala barracks, were identified. Nineteen of these subjects were selected. The selection criteria were: normal physical examination, normal d-Xylose absorption, normal urine and hematological analyses, three consecutive negative stool examinations for ova and parasites, normal 24-hour urinary creatinine excretion, and a weight/height ratio above 34 (Kilograms/meters).

2. Specification of the Mariscal Zavala Diet (M.Z. Diet): The daily dietary intake of the 19 selected soldiers was carefully investigated using both the 24 hour recall and direct weighing methods (Table VI.1). This information was used to define two different diets: The "M.Z. Diet" which was equivalent to the diet regularly consumed by these soldiers, and a "modified M.Z. diet" containing the same foods components as the M.Z. diet but formulated with lesser amounts of each food in order to provide only 2,800 Cals/day. Both of these diets were used in Phase III of this study. Although equicaloric, the components of the modified M.Z. diet and the rural metabolic diet were very different (Table VI.2), particularly in their content of beans and corn:

TABLE VI.1

Daily Dietary Intake of 19 Soldiers Studied At The "Regimiento Mariscal Zavala" While On Active Duty (1974)

	Values/24 Hours	
CALORIES (metabolizable)		3094 ± 62* Kcal.
Beans	580 ± 39 Cals. = 18.5 ± 1.0 % of total	
Corn	538 ± 5 Cals. = 17.5 ± 0.3 % of total	
Beans + Corn	1118 ± 44 Cals. = 36.0 ± 1.0 % of total	
PROTEINS		107.11 ± 2.2 grams
Of animal origin	4017 ± 2.9 g. = 36.5 ± 1.6 % of total	
Of vegetable origin	69.8 ± 1.9 g. = 63.5 ± 1.6 % of total	
FATS		60.30 ± 2.0 grams
Of animal origin	25.3 ± 2.9 g. = 43.9 ± 3.0 % of total	
Of vegetable origin	31.0 ± 1.6 g. = 56.1 ± 3.0 % of total	

PER KILOGRAM OF BODY WEIGHT

CALORIES = 49.80 ± 2.02 Calories
PROTEINS = 1.78 ± 0.05 grams
FATS = 1.00 ± 0.04 grams

*Mean ± S.E.

TABLE VI.2

Comparison of the "Modified Mariscal Zavala Diet" and the "Rural Metabolic Diet"

Component	Modified Mariscal Zavala Diet			Rural Metabolic Diet			Units
	Qty*	(% of Total)		Qty*	(% of Total)		
Total Calories (bomb)	3037	±11	100%	3081	±0.1	100%	Kcal
From beans	568	±14	19%	528	±0.0	17%	
From corn	589	± 0.0	19%	1266	±0.0	41%	
Beans, corn combined	1157	±14	38%	1794	±0.0	58%	
Total Nitrogen	18.2 ± 0.10		100%	18.1	±0.02	100%	g
Total Protein	113.7 ± 0.6		100%	113.1	±0.1	100%	g
Animal origin	43.1 ± 0.2		38%	38.9	±0.1	34%	
Vegetable origin	70.6 ± 0.6		62%	74.2	±0.0	66%	
Total Fats	38.7 ± 0.2		100%	32.5	±0.0	100%	g
Animal origin	14.9 ± 0.2		39%	7.0	±0.01	22%	
Vegetable origin	23.8 ± 0.1		61%	25.5	±0.0	78%	

*mean ± s.e.

Diet	Modified M.Z. Diet	Rural Diet
Approx. Bean: Corn Ratio	1:1	1:2.4
Percentage of Total Calories provided by corn + beans	39%	58%

Phase II: Determination of the obligatory nitrogen fecal loss in healthy soldiers

A low nitrogen diet (Table VI.3) was specially prepared for this purpose. Due to limitations of beds in the ward, the 19 soldiers had to be divided into two groups. Group 1 was studied in October 1974 and group 2 in November of the same year. The protocol was the same for both groups:

Day 1 = Admission to the metabolic ward. Physical checkup.

Day 1-3 = Fed the regular M.Z. diet. No balance study.

Day 4-6 = Adaption period to the low-nitrogen diet; 3-day balance study (Balance A).

Day 7-13 = 7-day balance study; subjects on low-nitrogen diet (Balance B).

Day 14-16 = Period of readjustment to M.Z. diet; no balance study.

The total period spent on the low-nitrogen diet was 10 days and a careful record of each subject's daily intake was kept. Biological material (stools and urine) were collected and analyzed to determine their nitrogen content.

Phase III: Detailed absorption studies using the rural metabolic diet

The protocol for this phase required 29 days of hospitalization. The activities carried out during this period of time were as follows:

Day 1-4 Mariscal Zavala ad. lib. diet (no control on consumption);

Day 5-8 Modified Mariscal Zavala diet (≈2800 metabolizable Calories/

TABLE VI.3

Low-Nitrogen Diet Given To Soldiers In Periods II-4 and II-5

Component	Quantity Per Day (grams)
Juice, Tang	20
Sugar	61
Bread (N-free Paygel G flour, General Mills)	360
Honey	34
Coffee	12
Margarine	10
Soft drink	579
Pudding	95
Marmalade	70
Cookie (N-free Paygel G flour + corn and cotton seed oil + flavoring)	11
Soup (n-free corn flour starch + flavoring + water)	480
Toast (N-free Paygel G flour, General Mills)	23
Vitamin supplement	
Approximate daily total intake	
Nitrogen	0.6 grams
Metabolizable calories	2500-2600 Kcal
Fat	33-34 grams

day); 4-day balance study (Balance 2).

Day 9-11 Adaption to Rural Metabolic Diet; no detailed absorption (balance) studies.

Day 12-14 Adaption to Rural Metabolic Diet; 3-day balance study (Balance 3).

Day 15-17 Rural Metabolic Diet, 3-day balance study (Balance 4).

Day 18-20 Rural Metabolic Diet, 3-day balance study (Balance 5).

Day 21-23 Rural Metabolic Diet, 3-day balance study (Balance 6).

Day 24-27 Rural Metabolic Diet, 4-day balance study (Balance 7).

This Phase III group was augmented by one additional subject (not in the original 19) who had been screened at Phase I and had met all criteria for admission to the study. Only 14 of the original group of 19 soldiers were studied in this phase.

Phase III-1 was a "baseline study" of absorption characteristics of the soldiers on their usual diet. Phase III-2 was a second "baseline study" of the soldiers on the "Modified Mariscal Zavala Diet" (Table VI.2) which was a controlled diet but differs from the "rural Metabolic Diet". In Phases III-3 through III-8, the soldiers were subjected to the "Rural Metabolic Diet," also summarized in Table IV.2. Phase III-3 is wholly an adaptation period and no balance studies were performed. Adaptation continued in Phase III-4 but balance studies were performed. Phases III-5 through III-8 (Balances 4-7) were directed toward establishing reference values

As mentioned earlier, the "Modified Zavala Diet" ("MZ") and the "Rural Metabolic Diet" ("RD") differ in the bean:corn ratios and the proportion of Calories provided by corn and beans combined.

Results

Nineteen soldiers were studied. Table IV.4 is a summary of some selected

TABLE VI.4

General Characteristics of 15 Soldiers Studied In Phase II

	Unit	Measurement
D-Xylose	%	28.30 ± 1.20*
Age	years	20.70 ± 0.30
Body Weight	Kg	60.10 ± 1.17
Height	cm	164.0 ± 1.20
Body Surface	$meter^2$	1.66 ± 0.10
Weight/Height	Kg/meter	37.00 ± 0.01
Plasma Proteins	g	8.10 ± 0.20
Hemoglobin	g/100 ml	17.40 ± 0.40
Hematocrit	/100 ml	49.00 ± 0.62
Urine Analysis		Normal
Direct Stool Examination		Essentially Negative

* Mean ± SE

clinical measurements of the 15 soldiers who completed Phase II.

1. Daily Dietary Intake Of Healthy Soldiers On Active Duty

Table VI.1 summarizes the average daily food intake of 19 soldiers surveyed for 3 consecutive days while on active duty and eating the regular Mariscal Zavala Diet. The caloric intake in these subjects was of 3094 ± 62 (mean ± SE) metabolizable Cals/day. The bean:corn ratio was 1:1 with beans and corn providing 36% of the total caloric intake. The average intake of proteins was 107.1 ± 2.2 g/day of which 36.5% was of animal origin and the rest of vegetable origin. The fat intake was 60.3 ± 2.0 g/day including 43.9% of animal origin. The quantities of calories, proteins, and fat ingested per kilogram of body weight meet the nutritional requriements of the individuals in the study.

2. Determination of Obligatory (Endogenous) Nitrogen Excretion

Of the 19 soldiers admitted to the metabolic ward, only 15 completed the studies described in Phase II of this program. Table VI.5 contains a summary of the results obtained during the two balance periods while these 15 subjects were on the low nitrogen diet. The intake of nitrogen, calories, and fat remained fairly constant during the 10-day period of the nitrogen-free diet. The amount of nitrogen and calories present in the stools every 24 hours decreased significantly from Balance A (days 4-6) to Balance B (days 7-13). Fecal nitrogen decreased from 1.8 ± 0.26 g/day (mean ± SE) to 0.9 ± 0.07 g/day and fecal calories decreased from 167.8 ± 20.2 Cals/day to 82.3 ± 6.22 Cals/day. Fecal fat also decreased, but only slightly, from 3.9 ± 0.45 g/day to 2.6 ± 0.32 g/day.

The improvement in the absorption of nitrogen,calories, and fat during Balance B was reflected in a drop in the fecal content of all these nutrients since the intake remained fairly stable.

TABLE VI.5

Summary of Detailed Absorption Studies in 15 Healthy Soldiers Given A Low Nitrogen (Nitrogen-Free) Diet

		Means
Age	(years)	20.7 ± 0.30*
Body Weight (BW)	(Kg)	60.1 ± 1.17
Height	(cm)	164.0 ± 1.20
Body Surface	(m^2)	1.66 ± 0.10

Intake		Values/24 Hours	
		Balance A (days 4-6)	Balance B (days 7-13)
Nitrogen Intake/Day			
Intake.....	total mg	598 ± 11.0	598 ± 11.0
	mg/Kg of BW	9.6 ± 0.50	9.6 ± 0.50
Stools.....	g	1.8 ± 0.26	0.9 ± 0.07
Caloric Intake/Day			
Intake.....	total Kcal	2530 ± 68.0	2527 ± 58.4
	Kcal/Kg of Bw	42.3 ± 0.90	42.1 ± 0.60
Stools.....	Kcal	167.8 ± 20.2	82.3 ± 6.22
Absorption.....	%	93.0 ± 0.86	96.6 ± 0.25
Fat Intake/Day			
Intake.....	total grams	34.4 ± 0.30	32.9 ± 0.29
	mg/Kg of BW	0.55 ± 0.01	0.52 ± 0.02
Stools.....	g	3.9 ± 0.45	2.6 ± 0.32
Absorption.....	%	88.6 ± 1.32	91.2 ± 0.96

*Mean ± SE

Table VI.6 summarizes endogenous nitrogen excretion (urinary and fecal), urinary creatinine excretion/day, changes in body weight, and the concentration of plasma proteins during the first 3 days and the last 3 days of the 10-day period on the low nitrogen diet. The body weight of these individuals remained stable all through this period. Average 24-hour urinary creatinine (expressed as the total amount excreted, mg/kg of BW or mg/cm of height or muscle mass) did not change. The concentration of plasma proteins decreased from 8.6 ± 0.1 g (Balance A) to 7.4 ± 0.1 g (Balance B). The endogenous nitrogen excretion also decreased significantly from one period to another. In the urine, these subjects excreted an average of 5.1 ± 0.27 g of nitrogen/day (equal to 82.1 ± 4.4 mg/kg of BW) during days 1-3 while during the last 3 days, the urinary nitrogen decreased to 2.6 ± 0.10 g/day (equal to 42.8 ± 1.6 mg/kg of BW). The daily decrease in endogenous urinary nitrogen excretion is presented in Figure VI.1. It can be seen that the decrease occurred mainly during the first 5 days. From the 6th day on, the urinary nitrogen excretion remained stable, between 2.25 ± 3.00 g/day (40-42 mg/kg of BW). On the other hand, the fecal nitrogen was 1.8 ± 0.26 g/day (30.4 ± 4.1 mg/kg of BW) during Balance A and decreased during Balance B to 0.9 ± 0.07 (14.8 ± 1.2 mg/kg of BW) (Table VI.6).

The behavior of these subjects while on a nitrogen-free diet was similar to that described in healthy individuals from industrialized countries. It is important to note that the body weight and the urinary excretion of creatinine did not change significantly during the 10-day period of study. The total nitrogen intake of 0.6 g/day was similar to that used by Calloway and Margen (1971)[1] and others. Nevertheless, when

[1]Calloway, D.H., and S. Margen. J. Nutrition 101: 205-216 (1971).

TABLE VI.6

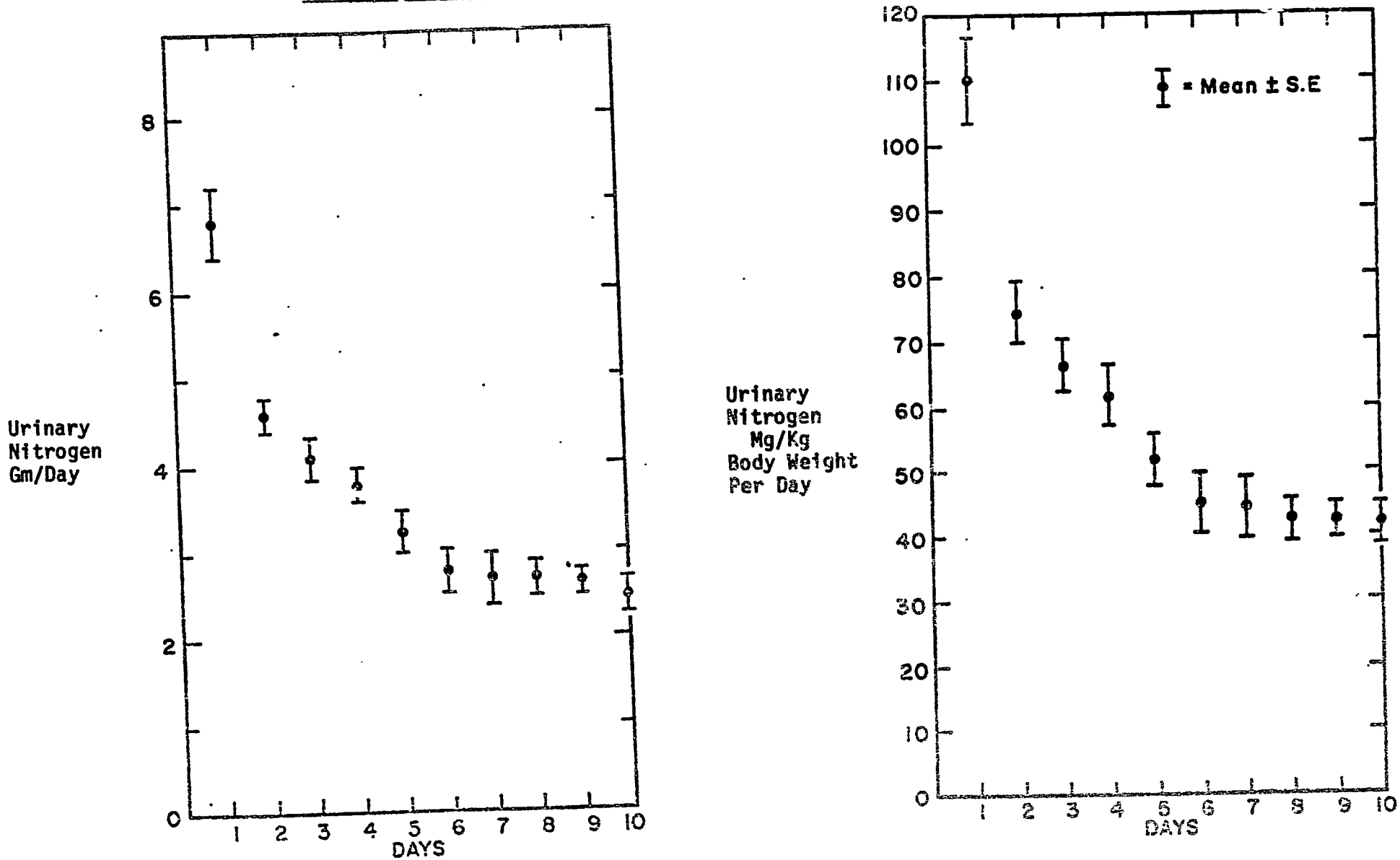
Endogenous Nitrogen Excretion Of 15 Healthy Soldiers On A Low Nitrogen Diet

Measurement	Days 1-3	Days 8-10*
Body Weight (Kg)	60.7 ± 0.70**	60.1 ± 0.70
Serum Proteins (g)	8.6 ± 0.10	7.4 ± 0.10
Urinary Creatinine/Day		
Total milligrams	1266 ± 68.0	1240 ± 60.0
mg per Kg BW	53.4 ± 3.00	54.1 ± 4.30
mg per cm Height	144.3 ± 7.50	150.8 ± 11.4
Muscle mass (Kg)	25.1 ± 1.40	24.9 ± 1.20
Urinary Nitrogen/Day		
Total grams	5.1 ± 0.27	2.6 ± 0.10
mg per Kg BW	82.1 ± 4.40	42.8 ± 1.60
g per g creatinine	4.2 ± 0.16	2.1 ± 0.10
	Days 1-3	Days 4-10
Fecal Nitrogen/Day		
Total	1.8 ± 0.26	0.9 ± 0.07
mg per Kg BW	30.4 ± 4.10	14.8 ± 1.20
mg per cm Height	11.2 ± 1.60	5.4 ± 0.40
mg per 100 Kcal eaten	76.5 ± 10.7	36.9 ± 3.00

* Days on N-free diet.
** Mean ± SE

FIGURE VI.1

Endogenous Urinary Nitrogen Excretion By 15 Guatemalan Soldiers Given A Low Nitrogen (Nitrogen-Free) Diet For 10 Days



this intake is expressed per unit of body weight, the intake of 9.6 mg/kg of BW is higher than the 6 mg/kg of BW calculated by Young and Scrimshaw (1968)[1]. This difference is due to the fact that our subjects were smaller and thinner than the individuals in the cited studies. Even so, the amount of endogenous urinary N obtained during the last 3 days of the study (42.8 ± 1.6 mg/kg of BW/day) falls within the range reported by Calloway and Margen. Fecal nitrogen during the same period was 14.8 ± 1.2 mg/kg of BW/day which is similar to that reported by the FAO/WHO Expert Committee (1973)[2]. Thus, it was concluded that the obligatory nitrogen fecal loss/day of healthy adult Guatemalan males, living at 4800 feet of altitude and with an average temperature of 22-24°C, is on the order of 14.8 ± 1.2 mg/kg of body weight.

3. Detailed Rural-Diet Absorption Studies

The principal objective of Phase III was to establish accurate reference values for absorption and excretion of nitrogen, fat, and calories. These reference values can be used to define malabsorption as measured in other Guatemalan populations.

Of the 19 soldiers studied in Phase II, only 15 were available for study in Phase III. During the course of Phase III, two of the 15 subjects experienced substantial diarrhea and were dismissed from the study. No data on these two subjects are presented. In addition, subjects 061 and 064 experienced very mild, or marginal, cases of diarrhea during Balances 7 and 6, respectively. The indications of diarrhea were: more than 3 bowel movements in a 24-hour period, stool volume greater than the average volume from previous days, and stools had changed from solid to

[1] Young, V.R. and N.S. Scrimshaw. Br. J. Nutr. 22: 9-20 (1968).

[2] World Health Organization Technical Report Series, No. 522. FAO Nutrition Meetings Report Series, No. 52. Published by FAO and WHO, 121 ps., 1973.

semiliquid or liquid. Neither subject presented mucus or blood in the stools. These marginal cases of diarrhea were determined not to be sufficiently severe to warrant exclusion of the data from summaries of results or estimates of reference values.

Table VI.7 contains a summary of the detailed absorption studies of Balances 2 to 7. It can be seen that the intake of nitrogen and calories in the subjects was very similar during Balances 2 through 7. Fat intake was relatively stable except during Balance 2 when the soldiers were receiving the 2800 Calorie modified "Mariscal Zavala" Diet. In contrast, the fecal excretion of nitrogen, calories, and fat fluctuated from balance to balance. Figures VI.2 and VI.3 show the pattern of this behavior. Figure VI.2 presents the changes in the average fecal loss of nitrogen, calories, and fat during Balances 2 through 7 as well as the respective absorption of these constituents. A significant increase in the fecal content of nitrogen and calories occurred during Balance 3, indicating a decrease in absorption. From Balance 4 to 7, the amount of nitrogen and calories present in the stools did not change substantially, although a slight improvement in the absorption of both was observed during Balance 7. The absorption of nitrogen in Balance 7 was 87.9 ± 1.4%, and that of calories was 93.0 ± 1.3%.

The differences in the content of fecal nitrogen, calories, and fat between Balances 3 and 7 and their absorption is summarized in Figure VI.4. The amount of the three nutrients in feces decreased in Balance 7, indicating an improvement in absorption in most of the subjects. Subjects 061 and 064 presented, on the contrary, a reverse pattern. The amount of nitrogen, calories, and fat in their feces increased in Balance 7 indicating a decrease in absorption. It was found that both had suffered

TABLE VI.7

Summary Of Detailed Absorption Studies Carried Out In 13 Healthy Soldiers Given The Rural Metabolic Diet During Phase III (All Values Are Given On A Per 24 Hour Basis)

	Balance Numbers / Days		2 / 5-8	3 / 12-14	4 / 15-17	5 / 18-20	6 / 21-23	7 / 24-27
NITROGEN	Intake	g	18.2 ± 0.2*	18.0 ± 0.0	17.8 ± 0.0	18.1 ± 0.0	17.8 ± 0.0	18.0 ± 0.0
	Stools	g	2.5 ± 0.3	3.4 ± 0.4	2.4 ± 0.3	2.9 ± 0.4	3.1 ± 0.4	[illegible].2 ± 0.[illegible]
	Urine	g	----------	11.6 ± 0.8	10.6 ± 0.6	12.3 ± 0.9	12.0 ± 0.5	11.3 ± 1.0
	Total excreta	g	----------	15.0 ± 0.9	13.9 ± 0.8	15.2 ± 0.9	15.1 ± 0.6	13.4 ± 1.1
	Balance	g	----------	3.0 ± 0.9	4.9 ± 0.8	2.9 ± 0.9	2.7 ± 0.6	5.4 ± 1.4
	Absorption	%	86.3 ± 2.3	80.6 ± 21.	86.4 ± 1.8	84.2 ± 1.9	82.8 ± 2.2	87.9 ± 1.4
	Retention	%	----------	16.0 ± 5.0	27.0 ± 4.9	16.1 ± 5.2	16.2 ± 3.2	25.2 ± 6.2
CALORIES	Intake (bomb)	Kcal	3022 ±14.6	3091 ± 0.0	3099 ± 0.3	3081 ± 0.8	3100 ± 0.0	3090 ± 0.7
	Stools (bomb)	Kcal	177 ±20.3	400 ±40.8	248 ±32.5	273 ±30.4	250 ±24.4	218 ±39.1
	Urine	g	----------	21.3 ± 1.4	26.3 ± 1.5	27.3 ± 1.8	26.6 ± 1.4	26.4 ± 2.0
	Total excreta	g	----------	361 ±40.9	275 ±32.8	300 ±30.6	2.8 ±25.4	245 ±39.5
	Absorption	%	94.1 ± 0.7	89.0 ± 1.3	92.0 ± 1.0	91.1 ± 1.0	91.4 ± 1.1	93.0 ± 1.3
	Retention	%	----------	88.3 ± 1.3	19.1 ± 1.1	90.3 ± 1.0	90.6 ± 1.2	92.1 ± 1.3
FATS	Intake	g	38.7 ± 0.2	34.5 ± 0.0	36.5 ± 0.0	32.5 ± 0.0	36.5 ± 0.0	34.5 ± 0.0
	Stools	g	5.0 ± 0.5	5.4 ± 0.5	5.4 ± 0.6	5.4 ± 0.5	4.7 ± 0.6	4.3 ± 0.6
	Absorption	%	87.1 ± 1.7	83.6 ± 1.5	85.1 ± 1.5	83.6 ± 1.7	87.1 ± 1.7	87.5 ± 1.6

*Mean ± S.E.

FIGURE VI.2

Fecal Excretion and Absorption of Nitrogen, Calories And Fats In A Group Of Soldiers Receiving Their Usual Diet And The Rural Metabolic Diet

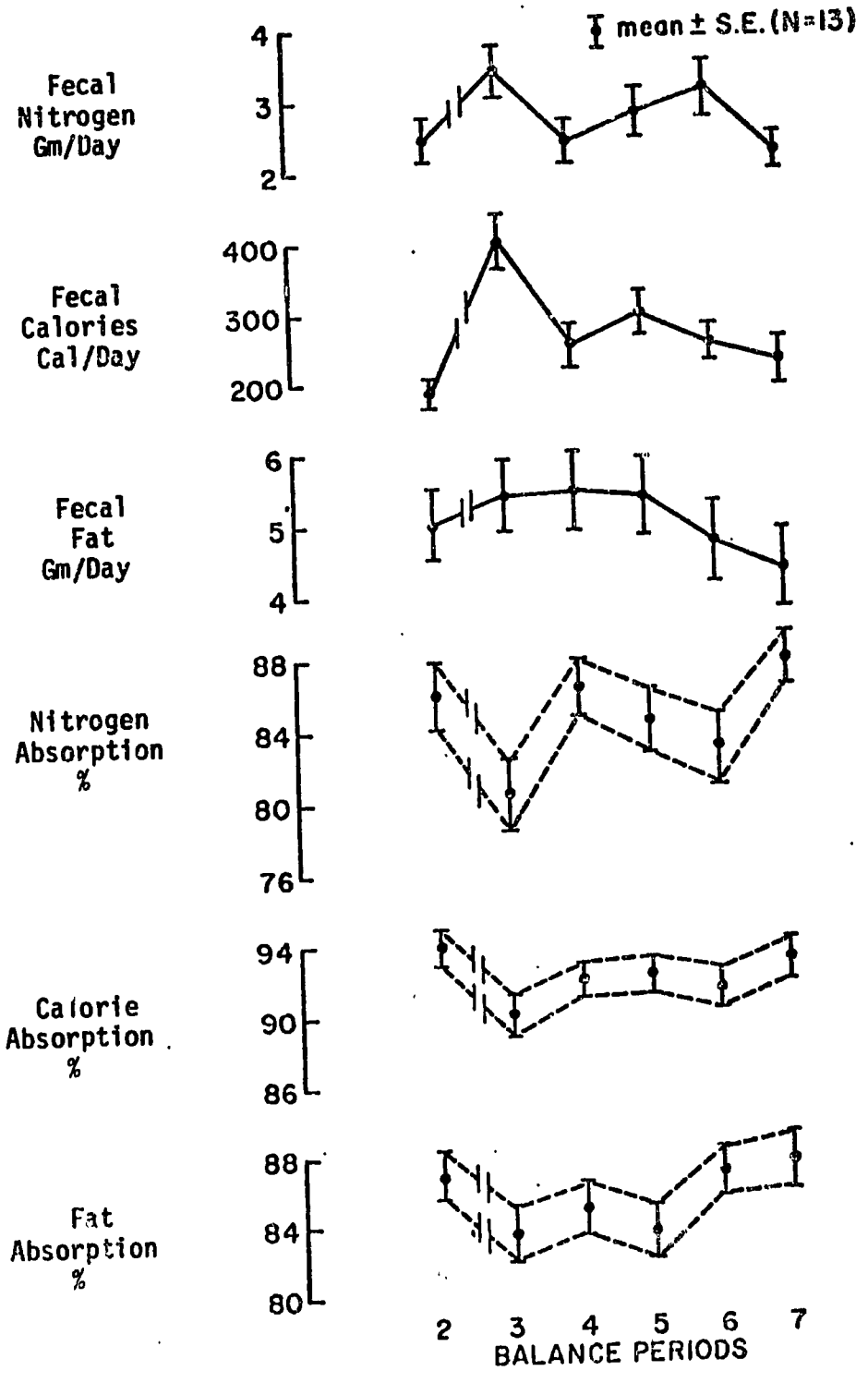


FIGURE VI.3

Fecal Excretion Of Calories In 13 Soldiers Receiving Their Usual Diet And The Rural Metabolic Diet

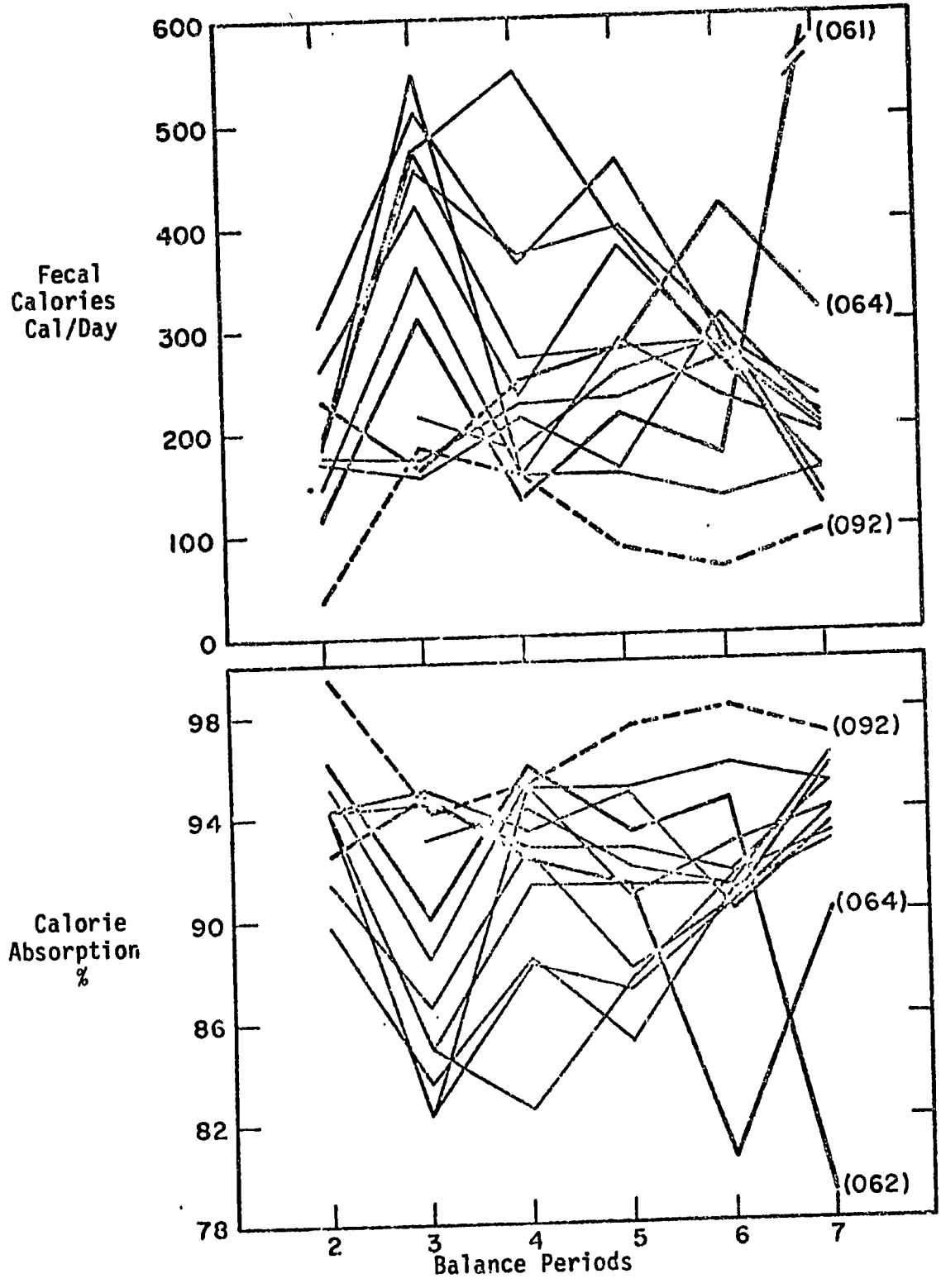
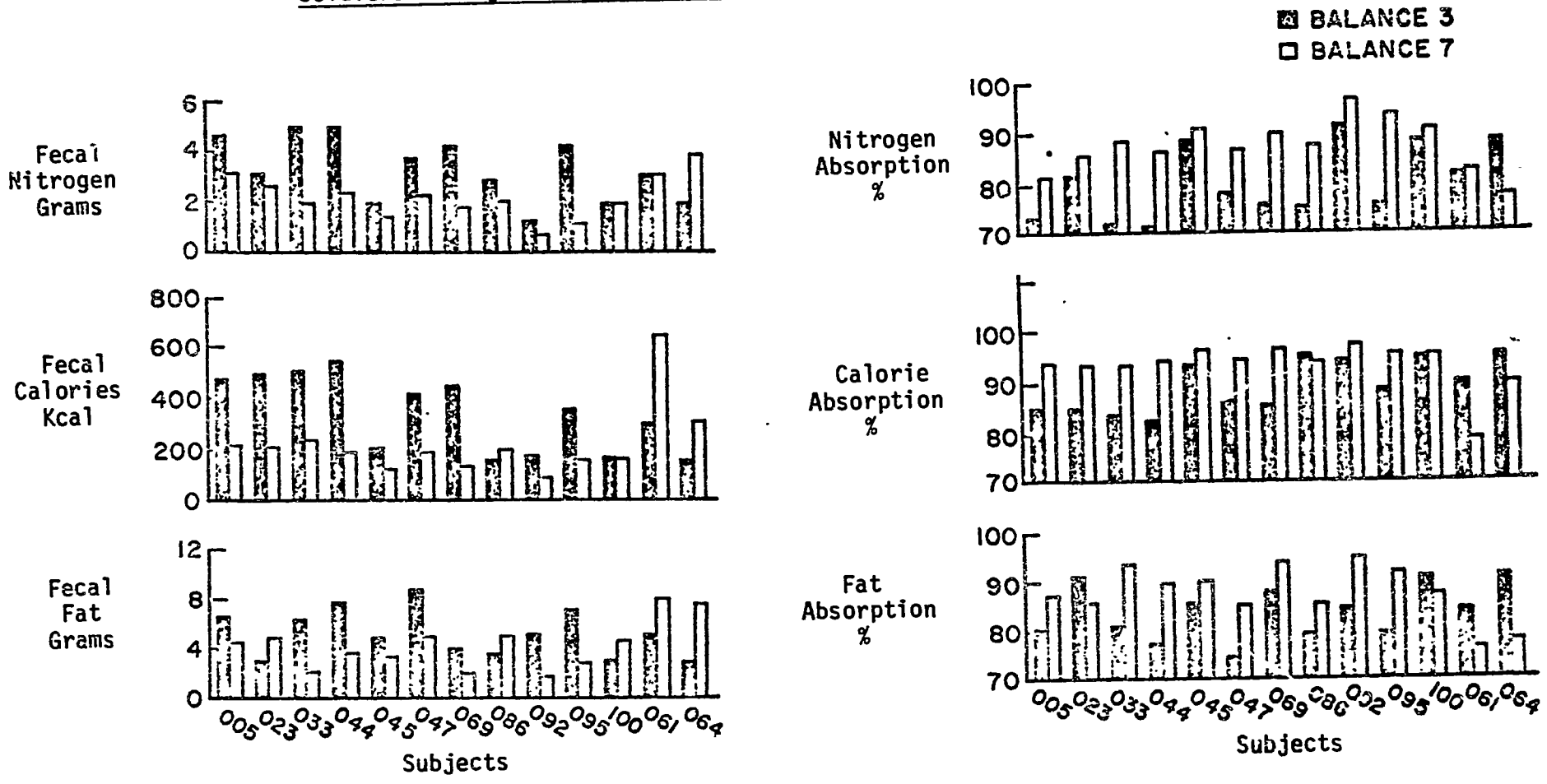


FIGURE VI.4

Fecal Loss and Absorption of Nitrogen, Calories and Fats of 13 Soldiers During Balance 3 and 7 of Phase III (Values/24 Hours)



marginal episodes of diarrhea.

Figure VI.3 shows the individual variations in fecal calorie excretion and in absorption during Balances 2 through 7. Wide fluctuations from one individual to another is evident. Even so, a majority of the subjects had a sharp increase in fecal calories, indicating a drop in absorption, during Balance 3. Three subjects seemed to follow rather different curves. Subjects 064 and 061 (heavy lines) presented a marked increase in fecal calorie excretion and a frank increase in absorption during the episodes of marginal diarrhea (064 during Balance 6 and 061 during Balance 7). Subject 092, on the contrary, consistently had a very low excretion of calories throughout the period of study and a very efficient capacity to absorb caloires.

The daily stool volume observed during each of the balance periods is presented in Figure VI.5. The smallest volume observed was 141.7 ± 20.7 (mean ± SE) grams/day during Balance 2. The highest stool volume observed was 263.1 ± 28.0 g/day during Balance 3.

4. Reference Values For Nutrient Absorption In Adult Males From The Pacific Lowlands of Guatemala

Malabsorption must be defined on the basis of some "norm" or reference value for a population. The primary objective of this study was to provide data for the accurate estimation of such reference values or "norms" for Guatemala. The reference value was defined as the sample mean of the observed values from the reference population of 13 soldiers. The mean values for total calories, nitrogen, and fat are presented, together with 95% confidence intervals and standard errors, in Table VI.8.

For example, the reference value for percent absorption of total Calories is 92.0%. There is a 95% certainty that the true population

FIGURE VI.5

Stool Volume In 13 Soldiers Given Their Usual Diet And The Rural Metabolic Diet

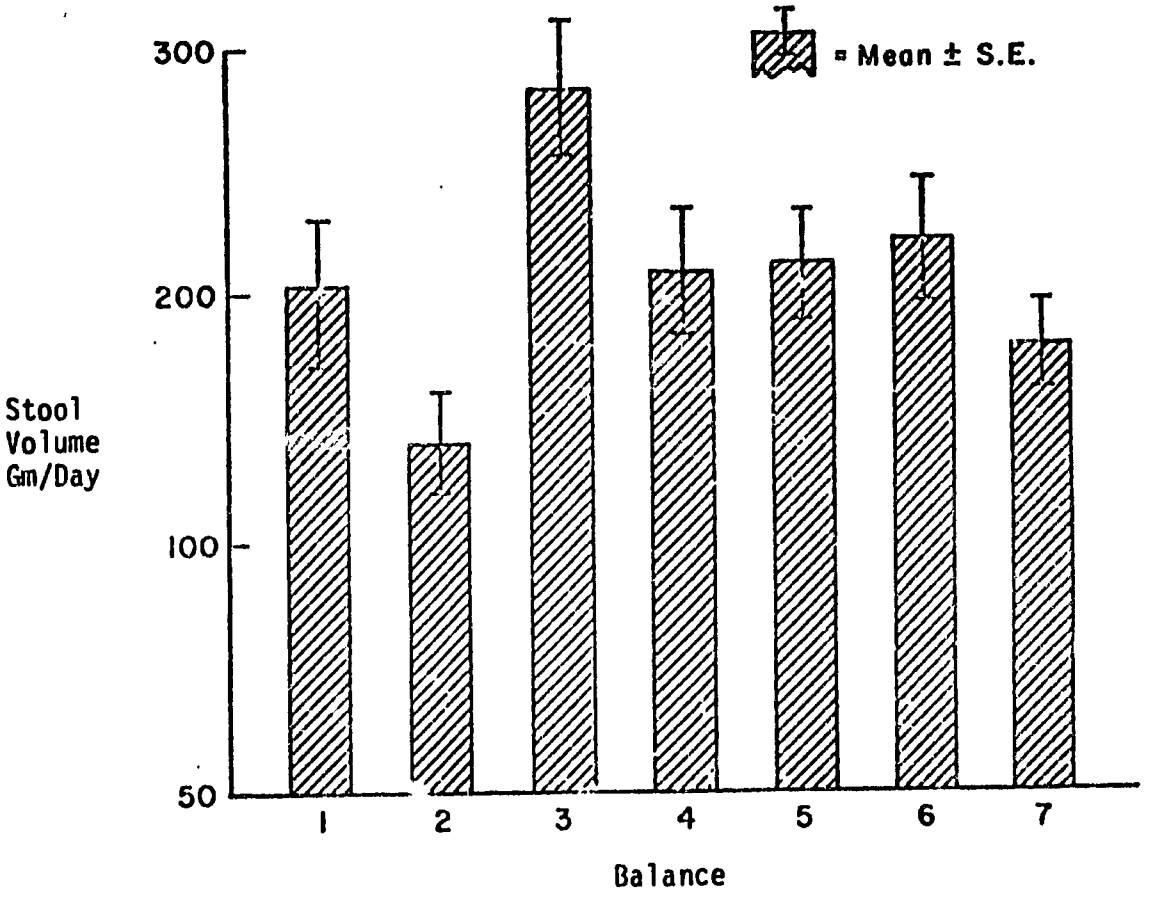


TABLE VI.8

Marginal Distributions Of Nutrient Absorption
In A Reference Group Of 13 Soldiers
(Four Balances Per Subject)

Nutrient Component	Measure	Mean	Standard Error ($s_{\bar{x}}$)	95% C.I. Low	95% C.I. High	Standard Deviation of Individual Observations
Total Calories	Excreted (Kcal)	247	20.1	203	291	114.5
	Absorbed (Kcal)	2846	20.3	2802	2890	115.6
	% Absorption	92.0	0.65	90.6	93.4	3.70
Nitrogen	Excreted (gm)	2.64	0.25	2.09	3.18	1.22
	Absorbed (gm)	15.3	0.26	14.7	15.9	1.23
	% Absorption	85.3	1.41	82.2	88.4	6.80
Fat	Excreted (gm)	4.95	0.38	4.12	5.78	1.98
	Absorbed (gm)	30.1	0.38	29.3	30.9	2.62
	% Absorption	85.8	1.08	83.4	83.1	5.76

mean lies between 90.6% and 93.4%. A subject, from a population for which the test population is a reasonable reference population, may be compared as follows. If the subject exhibited 85% absorption of total calories, the subject malabsorbed 92.0%-85.% = 7.0% of total calories. If the subject exhibited 95% absorption of total calories, the subject hyperabsorbed 3% of total caloires. The means of the other variables serve as reference values in the same manner.

The "standard deviation of an individual observation" column in Table VI.8 gives an indication of biological variability between subjects in a stable population. For example, if a population exhibited a mean of 85% absorption of total calories, one would expect approximately 95% of the individuals in the population to exhibit a percentage absorption of total calories between (approximately) 85%-2x3.7% = 77.6% and 85% + 2x3.7% = 92.4%, i.e., within the interval: mean ± 2x standard deviation (of an individual observation).

Tables VI.9 and VI.10 contain information about the estimated spread of the reference population under the statistical assumption of a Gaussian or normal distribution, which seems reasonable. The values from Table VI.9 contain the "best estimates" of the percentiles of the distribution. For example, given many repeated measurements over a long time, about 10% of the measurements from the reference population would be less than 87.3% absorption of total calories (from the third line of the table) while about 10% of the measurements would exceed 96.7% absorption of total calories (i.e., the 90-th percentile, third line). Those are the best estimates of the 10-th and 90-th percentiles. In this approach, the estimate is that 80% of the measurements would lie between 87.3% and 96.7% absorption of total calories. In contrast, there is a 95% certainty that 80% of the

TABLE VI.9

Tolerance Limits And Percentiles Of Individual Measurements

Tolerance Limits For Individual Measurements In A Population

Component	Measure	1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
Calories	Excreted	0.	43	92	147	185	217	247	277	309	347	402	451	554
	Absorbed	2536.	2640	2689	2749	2784	2816	2846	2876	2909	2947	3003	3052	3156
	% Absorbed	82.1	85.8	87.0	88.8	90.0	91.0	92.0	93.0	94.0	95.2	97.0	98.6	100.0
Nitrogen	Excreted	0.	0.47	0.99	1.57	1.98	2.32	2.64	2.95	3.30	3.70	4.29	4.81	5.91
	Absorbed	12.0	13.1	13.6	14.2	14.6	15.0	15.3	15.6	16.0	16.4	17.0	17.5	18.6
	% Absorbed	67.7	73.2	76.1	79.4	81.6	83.5	85.3	87.1	89.0	91.2	94.5	97.4	100.0
Fat	Excreted	0.	1.42	2.27	3.22	3.85	4.44	4.95	5.46	6.02	6.68	7.63	8.40	10.26
	Absorbed	23.1	25.6	26.5	27.0	28.7	29.4	30.1	30.8	31.5	32.4	33.7	34.8	37.1
	% Absorbed	70.4	75.5	78.0	80.8	82.7	84.3	85.8	87.3	89.9	90.8	93.6	96.1	100.0

PERCENTILES OF THE ESTIMATED NORMAL DISTRIBUTION OF INDIVIDUAL MEASUREMENTS

Component	Measure	1	5	10	20	30	40	50	60	70	80	90	95	99
Calories	Excreted	0.	59	100	151	187	218	247	276	307	343	390	435	613
	Absorbed	2577	2650	2690	2749	2783	2817	2846	2875	2907	2943	2994	3036	3113
	% Absorbed	83.4	85.5	87.3	88.9	90.1	91.0	92.0	92.9	93.9	95.1	96.7	98.1	100.0
Nitrogen	Excreted	0.	0.63	1.08	1.61	2.00	2.32	2.64	2.95	3.28	3.67	4.20	4.65	5.46
	Absorbed	12.4	13.3	13.7	14.3	14.7	15.0	15.3	15.6	15.9	16.3	16.9	17.3	18.2
	% Absorbed	69.5	74.1	76.8	79.6	81.7	83.6	85.3	87.0	88.9	91.0	94.0	96.8	100.0
Fat	Excreted	0.34	1.69	2.41	3.26	3.91	4.48	4.93	5.49	5.95	6.62	7.49	8.21	9.56
	Absorbed	24.0	25.8	26.7	27.9	28.7	29.4	30.1	30.8	31.5	32.3	33.5	34.4	36.2
	% Absorbed	72.4	76.3	78.4	81.0	82.8	84.3	85.8	87.3	88.8	90.6	93.2	95.3	99.2

TABLE VI.10

Estimates of Among-Subject and Within-Subject (among balance) Variance of Nutrients

Nutrient Component	Measure	Total Variance	Among-Subject Variance Component		Within-Subject Variance Component	
		σ^2	σ_a^2	%	σ_e^2	%
Total Calories	Excreted $(Kcal)^2$	13104.	2650.	20%	10454.	80%
	Absorbed $(Kcal)^2$	13375.	2691.	20%	10683.	80%
	% Absorption $(\%^2)$	13.72	2.78	20%	10.95	80%
Nitrogen	Excreted (gm^2)	1.48	0.61	41%	0.87	59%
	Absorbed (gm^2)	1.51	0.64	42%	0.87	58%
	% Absorption $(\%^2)$	46.21	19.19	42%	27.02	58%
Fat	Excreted (gm^2)	3.94	1.15	29%	2.79	71%
	Absorbed (gm^2)	6.88	0.19	3%	6.69	97%
	% Absorption $(\%^2)$	33.12	9.16	28%	23.96	72%

measurements would lie between 87.0% and 97.0% absorption of total calories. These values, 87.0% and 97.0%, come from corresponding entries of Table VI.9 (i.e., third line and the 10% and 90% tolerance limits). Similarly, we estimate 98% of future measurements of calories excreted would lie between 0 and 513, the estimated 1%-ile and 99%-ile, respectively, but we are 95% certain that the interval 0 to 554 would contain 98% of future measurements (assuming stability).

Tables VI.8 and VI.10 can be used to define malabsorption. These tables incorporate considerations of the precision of estimates of population means and the inherent biological variability of the measurements. There are two important statistical constraints which must be considered in the interpretation and analysis of these results. First, multiple observations from one subject cannot be considered to be statistically independent. The data from consecutive balances on one subject are in this category. As a consequence, multivariate (or multiresponse) statistical methods were required for the analysis of the data. The second point concerns the sample size. These data contain the results of 4 balance studies from each of 13 subjects. Of course, one would wish to have more than 13 subjects for the purpose of establishing reference values. The fact that there are 4 balance studies from each subject increases the "effective sample size" somewhat, but there is less information than would be available from 4x13 = 52 different subjects, given one balance per subject. This is taken into account in the analyses described.

If more subjects were available, the effect would be to increase the precision of the estimates of the means, i.e., to decrease the standard errors and decrease the lengths of confidence intervals. However, the confidence intervals used accurately reflect the precision attained

in this experiment.

Distributions of Measures of Nutrient Absorption

1. Nutrient Absorption

These data contain substantial information about the parameters of the distributions of measures of nutrient absorption in the reference population. These results are of biological and statistical interest and will be of importance to persons designing future studies.

2. Variance Components

One method of quantifying the variability of measurements in this study is to examine the "components" of the variance of an observation. One can pose the following model for one of the variables:

$$y_{ij} = \mu + a_i + e_{ij}$$

where:

Y_{ij} denotes a determination of one characteristic (e.g., percentage absorption of total calories) on the i-th subject during the j-th balance period, i = 1, 2, ..., 13, j = 4, 5, 6, 7.

μ denotes the (unknown) population mean value of the characteristic for this population (the reference value is an estimate of μ).

a_i denotes the average deviation about μ for the i-th subject; we assume that each subject operates around his own level of efficiency, the level of efficiency being $\mu + a_i$ for subject i.

e_{ij} is a term which includes two sources of variation which

are indistinguishable in these data. First, even though each subject is assumed to operate at his own level of $\mu + a_i$, we assume, based the data from the reference group, that the subject's response varies about $\mu + a_i$ from one balance to another. The term e_{ij} includes this variability. In addition, we recognize that there is some laboratory measurement variability and this is also included in the e_{ij} term. Thus e_{ij} is the deviation $y_{ij} - (\mu + a_i)$ for the i-th subject, j-th balance, and may come from two or more sources.

There are three further assumptions. First, we assume the e_{ij} are random and independent, i.e., a subject's deviation from his characteristic level of efficiency, $\mu + a_i$, on one balance is unrelated to his deviation on any other balance. We also assume one subject's deviations from his characteristic level of efficiency is unrelated to any other subject's deviations. We assume the long term average of the e_{ij}, denoted $E(e_{ij})$, is zero and the variance of each e_{ij} is σ_e^2, i.e., all e_{ij} terms have the same variance. The parameter σ_e^2 is a measure of a subject's variability from one balance to another in the same series of balances.

We assume the a_i, the deviation of the individual's characteristic level of efficiency from the population characteristic level of efficiency, is random, which is true if the subjects are selected at random from the population and is also true under other circumstances. We assume $Var(a_i) = \sigma_a^2$, i.e., that each a_i has the same variance. The parameter σ_a^2 is a measure of the subject-to-subject variability under the conditions of this experiment. We further assume the a_i are all independent of the e_{ij}.

Given all these assumptions, the objective is to estimate the parameters μ, σ_a^2, and σ_e^2 for each measure of nutrient component absorption. In this case the experiment is a hierarchal design, which permits estimation of the parameters. The estimates of the μ's were discussed in the previous section. The estimates of the components of variance, σ_a^2 and σ_e^2, are given in Table VI.10.

Note that the estimate of the variance of an individual observation (one subject, one balance) is $\sigma^2 = \sigma_a^2 + \sigma_e^2$, which is estimated as $\hat{\sigma}^2 = \hat{\sigma}_a^2 + \hat{\sigma}_e^2$. It is interesting to consider the percentage of the estimated total variance ($\hat{\sigma}^2$) contributed by each component ($\hat{\sigma}_a^2$, $\hat{\sigma}_e^2$), viz,

$$\frac{100\,\hat{\sigma}_a^2}{\hat{\sigma}_a^2+\hat{\sigma}_e^2}\,\% \text{ and } \frac{100\,\hat{\sigma}_e^2}{\hat{\sigma}_a^2+\hat{\sigma}_e^2}.$$ These percentages are presented in Table VI.10.

The percentages of total variance (Table VI.10) illustrate that the within-subject balance-to-balance variation is at least as large as the among-subject variability. This indicates that the subjects are quite variable from balance to balance. A subject who is a "malabsorber" (absorption below the reference value) today could well be a hyperabsorber three days from now and a malabsorber again next week. Variability of this sort is not unusual in biological measurements.

Correlations

One expects that when multiple measurements are made on one subject the measurements will be correlated. This is indeed the case with the present data.

Table VI.11 contains some of the correlations of interest relating

TABLE VI.II

Correlations Between Measures of Nutrient Absorption

Excretion Measures	Nitrogen	Calories	Fat
Nitrogen	1.00	0.85	0.79
Calories	0.85	1.00	0.81
Fat	0.79	0.81	1.00

Absorption Measures	Nitrogen	Calories	Fat
Nitrogen	1.00	0.86	0.79
Calories	0.86	1.00	0.82
Fat	0.79	0.82	1.00

% Absorption Measures	Nitrogen	Calories	Fat
Nitrogen	1.00	0.85	0.79
Calories	0.85	1.00	0.82
Fat	0.79	0.82	1.00

to multiple measurements. First, the correlations between measures of excretion, absorption, and percentage absorption which are the three correlation matrices in the Table, are essentially identical. This relationship is expected because these three types of measures are nearly linear functions of each other.

In each case the correlations are quite high, ranging from 0.79 to 0.85. This indicates that any underlying factors which cause soldiers to differ from one another, tend to affect the absorption of nitrogen, calories, and fat in a proportional manner. However the correlations are not sufficiently close to 1.00 to support a conclusion that a single underlying factor is being measured in three different scales.

If all the assumptions of the variance components model discussed above are correct, one would expect the correlation between any two balances on the same subject to be estimates of $[\sigma_a^2/(\sigma_a^2 + \sigma_e^2)]^{1/2}$. The approximate results are:

Variable	Approximate Correlation (Variance Components Model)
% Absorption Calories	0.45
% Absorption Nitrogen	0.64
% Absorption Fats	0.84

The correlations in Table VI.12 tend not to be constant within each matrix, suggesting that the variance components model may be inappropriate. In fact, the correlations tend to decrease with "distance" in time, i.e., correlations between two successive balance studies are higher than correlations between the fourth and sixth or fifth and seventh balances. These, in turn, tend to be larger than correlations between the fourth

TABLE VI.12

Correlations Between Determinations of % Absorption From Different Balance Studies On 13 Soldiers

Percentage Absorption of Calories	Balance 4	5	6	7
Balance 4	1.00	0.72	0.39	-0.18
5	0.72	1.00	0.54	-0.02
6	0.39	0.54	1.00	0.02
7	-0.18	-0.02	0.02	1.00
Percentage Absorption of Nitrogen				
Balance 4	1.00	0.72	0.25	0.17
5	0.72	1.00	0.50	0.50
6	0.25	0.50	1.00	0.63
7	0.17	0.50	0.63	1.00
Percentage Absorption of Fat				
Balance 4	1.00	0.56	0.34	-0.13
5	0.56	1.00	0.46	0.09
6	0.34	0.46	1.00	0.49
7	-0.13	0.09	0.49	1.00

and sixth or fifth and seventh balances. These, in turn, tend to be larger than correlations between the fourth and seventh balances. These results are based upon only 13 observations and are not conclusive, but they indicate a stochastic or growth curve model may be more appropriate than a variance components model. This topic is also the subject of further study. Regardless of the validity of the model, the estimates of the variance components are useful statistics in that they clearly illustrate the large magnitude of the within-subject variability relative to among-subject variability. This is one of the most important statistics of these studies.

VII. Detailed Absorption Studies

Experimental Design and Results of Detailed Absorption Studies

1. Selection and Participation of Subjects

The details of the initial selection of subjects for detailed absorption studies have been presented in the Methodology Report. Only a summary of the procedure is presented here.

Adult male inhabitants (15 or more years of age) of each village who indicated a willingness to participate in the studies were given a medical screening and a d-Xylose absorption test. Within each village this population was stratified into three equally sized groups on the basis of d-Xylose absorption results.

The appropriate sample size for the experiment was based on statistical computations of estimated intestinal absorption measurements. These calculations indicated that the sample size should comprise at least 60 subjects from each of the two villages. A stratified random sample of 75 subjects was selected from each community, with stratification based upon the outcome of the preliminary d-Xylose tests. The additional 15 subjects in each village were to be used as a pool to replace "dropouts" from the study as these occurred.

After the initial selection of subjects, the rate of participation was unexpectedly and sharply reduced by subjects moving to other villages, subsequent refusal to participate and inability to schedule the subjects' participation in the studies at appropriate times. Over the four years of the study the initial chosen sample of 75 per village was extended to a total of 98 subjects in Florida Aceituno (FA) and 97 subjects in Guanagazapa (GU) to compensate for the high dropout rate.

Table VII.1 and Figure VII.1 presents information on the numbers of subjects who participated in the studies (through every possible combination of samples) from 1973 through 1976. Following is a brief summary of participation by the villages.

	FA	GU	Total
Total number in pool of participants selected (for four years)	98	97	195
Subjects who never participated	-19	-24	-43
Subjects who participated at least once in an absorption test	79	73	152
Subjects who participated at least once, but not in all four years	42	28	70
Subjects who participated in all four years	37	45	82

Prior to the study it was assumed a subject's absorption for the various years of the study would be highly correlated, in that a "malabsorber" in 1973 would probably always be a malabsorber and a "hyperabsorber" in 1973 would continue to be a "hyperabsorber". This study has shown the converse. Results from year to year are not highly correlated. This low correlation makes the subjects appear as members of an annual random sample, rather than a one-time random sample of their populations. Therefore, the fact that some of the subsets participated in all four studies and others participated in three or less of the annual tests is not of real importance to the analysis of the data.

2. Summary of the Metabolic Ward Schedule and Protocol

A summary of the metabolic study procedures which are most important to an understnading of the results are presented in the following sections. Extensive details of these protocols, as well as the study design, have

TABLE VII.1

Metabolic Ward Longitudinal Sample
(Marginal Frequencies of Participation)

1976	1975	1974	1973	FA	GU	BOTH
1	1	1	1	37	45	82
			0	11	8	19
			total	48	53	101
		0	1	1	0	1
			0	1	3	4
			total	2	3	5
		total	1	38	45	83
			0	12	11	23
			total	50	56	106
	0	1	1	0	0	0
			0	0	0	0
			total	0	0	0
		0	1	0	1	1
			0	10	3	13
			total	10	4	14
		total	1	0	1	1
			0	10	3	13
			total	10	4	14
	total	1	1	37	45	82
			0	11	8	19
			total	48	53	101
		0	1	1	1	2
			0	11	6	17
			total	12	7	19
		total	1	38	46	84
			0	22	14	36
			total	60	60	120

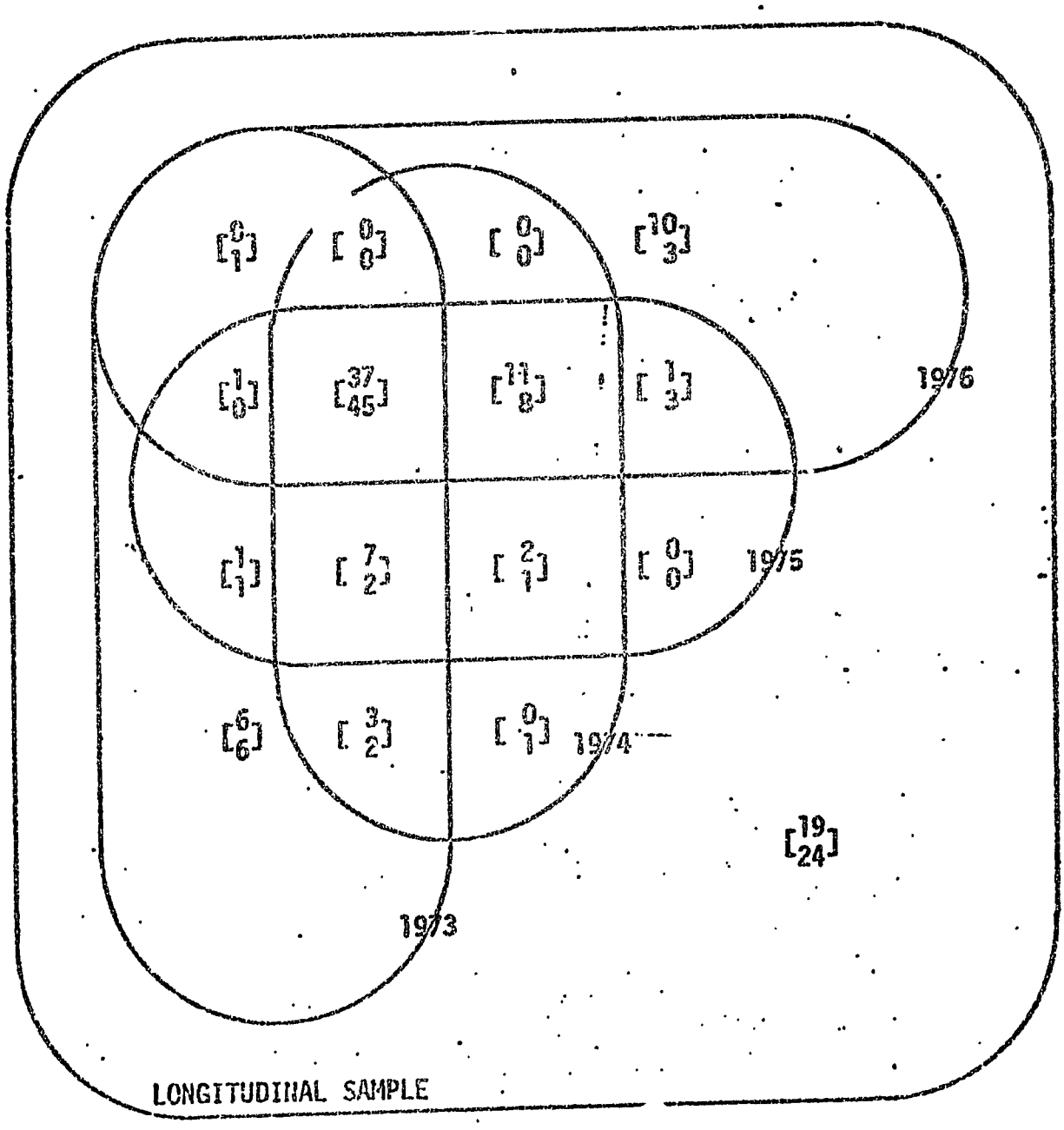
1976	1975	1974	1973	FA	GU	BOTH
0	1	1	1	7	2	9
			0	2	1	3
			total	9	3	12
		0	1	1	1	2
			0	0	0	0
			total	1	1	2
		total	1	8	3	11
			0	2	1	3
			total	10	4	14
	0	1	1	3	2	5
			0	0	1	1
			total	3	3	6
		0	1	6	6	12
			0	19	24	43
			total	25	30	55
		total	1	9	8	17
			0	19	25	44
			total	28	33	61
	total	1	1	10	4	14
			0	2	2	4
			total	12	6	18
		0	1	7	7	14
			0	19	24	43
			total	26	31	57
		total	1	17	11	28
			0	21	26	47
			total	38	37	75

1976	1975	1974	1973	FA	GU	BOTH
TOTAL	1	1	1	44	47	91
			0	13	9	22
			total	57	56	113
		0	1	2	1	3
			0	1	3	4
			total	3	4	7
		total	1	46	48	94
			0	14	12	26
			total	60	60	120
	0	1	1	3	2	5
			0	0	1	1
			total	3	3	6
		0	1	6	7	13
			0	29	27	56
			total	35	34	69
		total	1	9	9	18
			0	29	28	57
			total	38	37	75
	total	1	1	47	49	96
			0	13	10	23
			total	60	59	119
		0	1	8	8	16
			0	30	30	60
			total	38	38	76
		total	1	55	57	112
			0	43	40	83
			total	98	97	195

Key: 1= indicates participation in the given year
0= indicates non-participation in the given year

FIGURE VII.1

Metabolic Ward Sample
(Frequency of Participation)



Key: [98 / 97] subjects from Florida Aceituno / subjects from Guanagazapa

been presented in previous reports and are found in the Methodology Report.

Metabolic studies were performed at a facility adjacent to a National Hospital in Esquintla, Guatemala. Esquintla is located in the Pacific coastal lowlands approximately midway between the two study communities. Approximately 6-8 subjects were scheduled for examination in each study period. The 1973 studies lasted 6 days for each group and this period was extended to 9 days for 1974-1976 studies.

Studies were initiated in June of each year and continued through November. Study groups were chosen alternatively between villages. During each six- or nine-day study all subjects were from only one of the two villages. Subjects from the two villages were never taken together in the same study period.

Scheduling of subjects for the metabolic ward was complicated by a number of factors. The scheduling had to be done several weeks in advance. Episodes of diarrhea or other types of morbidity in the two weeks prior to the study period led to exclusion of the subject. Also, the required six- or nine-day absence from home and work made scheduling difficult.

The schedule of activities within a study period changed over the first three years of the study. These schedules are shown in Tables VII.2, 3 and 4. The 1973 studies included only a single three-day balance period. An additional three-day balance period was added in 1974 to study the effects of adaptation to both the metabolic ward and diet. Subjects were assigned to one of three dietary regimens in the first balance period but the second balance period was identical for all subjects. The 1975 and 1976 studies involved two consecutive and identical three-day balance periods.

The treatment of subjects in the second balance period of the 1974,

TABLE VII.2

Schedule of Activities for the 1973 Metabolic Studies

Day	Hour	Description of Activity
Day 1	11:00 hours	Admission
		Physical check-up and anthropometry
	12:00 hours	Beginning of 72-hour balance period (Carbon 1g, P.O.)
Day 2	----------	Continuation of balance
	6:00 hours	Blood drawn for hematological work-up.
Day 3	----------	Continuation of balance
Day 4	12:00 hours	End of balance period (Carmine C.5 g, P.O.)
Day 5	----------	No activities
Day 6	6:00 hours	d-Xylose absorption test
	12:00 hours	Discharged.

Notes:

1. Stool cultures for parasitological and microbiological studies were obtained during days 1 or 2.

2. Body weight was measured every day at 6:00 and 18:00 hours.

3. Each subject exercised for 10 minutes every day at 9:00 and 16:00 hours on a stationary bicycle while under close supervision. A speed between 10-15 miles/hour was maintained.

4. The 2800 Calorie rural metabolic diet was given through the entire period of hospitalization.

TABLE VII.3

Schedule of Activities for the 1974 Metabolic Studies

Day	Hour	Description of Activity
Day 1	11:00 hours	Admission - Physical check-up and anthropometry
	12:00 hours	Beginning of Balance I. 2000, 2400 or 2800 Kcal/day diet to match the pre-study diet. (Administer Carbon, 1 g., P.O.)
Day 2	----------	Continuation of Balance I
	6:00 hours	Blood drawn for hematological work-up.
Day 3	----------	Continuation of Balance I
Day 4	12:00 hours	End of Balance I - (Carmine 0.5 g, P.O.) Beginning of Balance II. 2800 Kcal/day Rural Metabolic Diet
Day 5	----------	Continuation of Balance II
Day 6	----------	Continuation of Balance II
Day 7	12:00 hours	End of Balance II (Carbon 1 g, P.O.)
Day 8	----------	No activities
Day 9	6:00 hours	d-Xylose test
	12:00 hours	Discharged

Notes:

1. Stool samples for parasitological and microbiological studies were obtained on day 1 or 2.

2. Body weight was measured every day at 6:00, 12:00, 18:00 and 21:00 hours.

3. The schedule and intensity of daily exercise were identical to the 1973 study.

4. During Balance I, subjects were given either 2000, 2400 or 2800 Calories per day to approximate the caloric intake that the individual had the week prior to admission to the rural metabolic ward (determined through a detailed dietary survey). During Balance II, all study individuals received the regular 2800 Kcal/day rural metabolic diet. All diets given in both Balance periods contained indentical proportions of the same food components. The decrease in calories was achieved through proportional reduction of the quantities of the different foods.

TABLE VII.4

Schedule of Activities for 1975 and 1976 Metabolic Studies

Day	Hour	Description of Activity
Day 1	11:00 hours	Admission - Physical check-up and anthropometry
	12:00 hours	Beginning of Balance I. 2800 Kcal/day diet. (Administer Carbon, 1 g., P.O.)
Day 2	----------	Continuation of Balance I
	6:00 hours	Blood drawn for hematological work-up
Day 3	----------	Continuation of Balance I
Day 4	12:00 hours	End of Balance 1 (Carmine 0.5 g., P.O.) Beginning of Balance II. 2800 Kcal/day Rural Metabolic Diet
Day 5	----------	Continuation of Balance II
Day 6	----------	Continuation of Balance II
Day 7	12:00 hours	End of Balance II (Carbon 1 g., P.O.)
Day 8	----------	No activities
Day 9	6:00 hours	d-Xylose test
	12:00 hours	Discharged.

Notes:

1. Stool samples for parasitological and microbiological studies were obtained on day 1 or 2.

2. Body weight was measured every day at 6:00, 12:00, 18:00 and 21:00 hours.

3. The schedule and intensity of dialy exercise were identical to the 1973 study.

4. During Balance 1, each subject was given 2800 Calories per day. During Balance II, all study individuals received the same 2800 Kcal/day rural metabolic diet. Diets given in both Balance periods contained indentical proportions of the same food components.

1975 and 1976 studies was identical to the treatment of subjects in the single 1973 balance period except for the "adaptation" balance period. An abbreviated list of the categories of information collected in the metabolic ward is shown in Table VII.5.

The protocols and methodology for the detailed absorption studies are presented in the Methodology Report. Initial data handling at INCAP required hand calculations for the integration of the 10,000 laboratory results from each annual sampling. Later these calculations were programmed for the computer. The UNC-CH data management group has done extensive data checks with subsequent iterations of the data. Some further iterations are still required. The current edit checks still reveal small anomalies in the data and the INCAP computer programs for calculating the various measures of absorption capacity may still result in small systematic errors in the data. Systematic errors in a computer program would affect the data from both villages and in all applicable years in the same way. Therefore, even with these small systematic errors, the general trends reported here would remain even with subsequent corrections in the computer programs.

3. Description of the Tables

The trends in the absorption of nitrogen, calories, fat, and d-Xylose are summarized in Tables VII.6 through VII.13 and in Figures VII.2 through VII.9. The data have been analyzed in two ways. The results for the group of "all subjects" are for those men who participated in any one year of the study and are presented in Tables VII.6 through VII.9 and Figuares VII.2 through VII.5. The men who participated in all balances for all four years are called the "longitudinal sample". The results for this subset of men are presented in Tables VII.10 through VII.13 and Figures

TABLE VII.5

Information Collected from Metabolic Ward Subjects

Category	Description
Identification	Name, community, correlative number, metabolic ward identification number, family number, relative position within family.
Anthropometry and Nutritional Status	Height, weight, arm circumference, tricipital skinfold thickness, shoulder-thoracic-abdominal-girdle circumferences, body surface area index (computed, not measured), 24-hour consecutive urinary creatinine excretion, serum folate, and blood vitamin B_{12} level.
Parasitological Examinations	
Stool Cultures	
Detailed Absorption Studies	Evaluate calorie, nitrogen, and fat absorption

VII.6 through VII.9.

Age was found to have a slight effect upon the absorption of nutrients in the subjects of this study, therefore, all results are presented as "age adjusted means". The results in the tables and figures are not the actual arithmetic means of the observed measurements. These results (means) have been adjusted for slight variations in age to reflect the percentage absorption at the average age of 26 years, 10 months.

Tables VII.6 - VII.13 have the same format. The variable for percent absorption of nitrogen, calories, fat or d-Xylose, and the group of subjects to which the statistics apply (all subjects or longitudinal sample) are identified in the title of each table. The first panel of the table (Table VII.6 for example) contains the age-adjusted means and corresponding standard errors for each village group for each of the seven balances. The seven balances include the one balance in 1973 and each of the pair of balances in the remaining years. For example, the first balance in 1974 is labeled "74A" and the second "74B". The annual means (averaged over the two balances) and their standard errors are presented in the same panel, just below the individual balance means. The values for 1973 are simply repeated for comparison since there was only one balance in that year.

The third pair of columns in the first panel contain the means, averaged across village groups, for each of the seven balances and, again, for each year (averaged over balances).

The farthest right of the four columns in the first panel contains comparisons between the villages. These are presented first by year and balance and then by year and average of the two annual balances (except for 1973). The "mean" column contains the difference between the village

means. For example, in Table VII.6, the first mean difference corresponds to 1973. The difference in the means for Guanagazapa and Florida Aceituno mean is approximately, 77.09 - 74.16 = 2.93%, with a corresponding standard error of 1.47%. A t-test of the null hypothesis of no village difference in percent absorption of nitrogen in 1973 gives a t-value of 1.98 which is significant at the 0.047 level (column labelled "sig").

Not all the digits shown are significant. The computer program used for these analyses performs compuatations to 16 significant digits and prints out the six most significant digits. The textual material has been copied directly from the computer printout in order to avoid copying errors in retyping.

The middle panel of each table contains yearly comparisons of the age-adjusted means. Each line contains the comparison of a single study year versus 1976. For example, the first line of the middle panel contains the difference in mean absorption (of nitrogen, in Table VII.6), computed as the 1976 mean (over two balances) minus the 1973 mean (only one balance). The second column contains the corresponding standard error. A t-value for the test of the null hypothesis of no difference in the annual means is in the third column. This measurement is followed by the significance level of the t-statistic. For example, in Table VII.6 the 1976 mean (over both balances) for Florida Aceituno for percent absorption of nitrogen was 77.20%, while the 1973 mean (one balance only) was 74.16%. The difference (1976 minus 1973) is approximately 3.04%, with a standard error of approximately 1.30%. A t-test of the null hypothesis for a 1976 vs 1973 difference yields a t-value of 2.38, which is significant at the 0.018 level. Similar computations are presented for comparisons of 1976 vs 1974 and 1976 vs 1975 and all the computations are repeated

for the Guanagazapa subjects.

The third panel of each of Tables VII.6 to VII.13 presents the annual differences of means for the designated variable taken over villages and the differences of annual between-village comparisons. In the left side of the panel, the first line contains the comparison of the 1976 means versus the corresponding mean for 1973. In the case of percent absorption of nitrogen, for example, the 1976 mean (average FA and GU) is shown in mid-panel 1 of Table VII.6 to be 80.71%, compared with a 1973 mean of 75.62%. The difference (1976 minus 1973) shows an increase of 5.09% absorption of nitrogen, with a standard error of 0.90%, which yields a t-value of 5.66, significant at the 2.1×10^{-8} level.

The right side of the third panel shows how the differences between village groups changed over the four years of the study. The village differences from the farthest right section of the first panel are compared (with each year being compared against 1976). In the case of percent absorption of nitrogen (Table VII.6), the results (panel 1) show that in 1973 the subjects from Florida Aceituno absorbed 2.93% less nitrogen than the Guanagazapa subjects. In 1976, the subjects from Guanagazapa absorbed 7.01% more than those from Florida Aceituno. The difference, 7.01% - 2.93% = 4.08%, shows a substantial improvement by the Guanagazapa subjects relative to the Florida Aceituno subjects over the four years of the study. The standard error of the comparison is 1.79%. A t-test of the null hypothesis of a zero difference yields a t-value of 2.28, significant at the 0.023 level.

The footnote for each table shows the pooled estimate of the sample variance for the analysis, together with the number of degrees of freedom associated with the variance estimate. This value of the degrees of freedom

TABLE VII.6

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Nitrogen For All Metabolic Ward Participants

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	74.1597	1.05452	77.09	1.03557	75.6248	0.739405	2.93034	1.47715	1.98378	0.0476192
74A	77.0233	1.01041	78.9227	1.0191	77.973	0.718668	1.89936	1.43285	1.32559	0.185353
74B	71.9497	1.01929	75.5478	1.02777	73.7487	0.724981	3.59818	1.44505	2.49001	0.012974
75A	79.0876	1.01229	81.0528	1.02918	80.0702	0.724052	1.96514	1.43906	1.36557	0.172454
75B	75.5729	1.01232	76.5998	1.02025	76.0864	0.720812	1.02688	1.43286	0.716667	0.473787
76A	77.4665	1.02249	84.5594	1.01372	81.0129	0.723389	7.09288	1.43295	4.9502	9.02852-07
76B	76.9422	1.03221	83.8729	1.01375	80.4075	0.727198	6.93069	1.43911	4.81594	.0000017496
73	74.1597	1.05452	77.09	1.03557	75.6248	0.739405	2.93034	1.47715	1.98373	0.0476192
74Avg	74.4865	0.718795	77.2353	0.724852	75.8609	0.512069	2.74877	1.0175	2.70151	0.0070474
75Avg	77.3303	0.718201	78.8263	0.726652	78.0783	0.51397	1.49601	1.01539	1.47334	0.141049
76Avg	77.2043	0.730352	84.2161	0.720216	80.7102	0.517978	7.01178	1.0154	6.90541	0

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	3.04468	1.27943	2.37972	0.017557	7.12612	1.25899	5.66019	2.1009E-08
76-74	2.71784	1.01864	2.66811	0.007781	6.98086	1.01619	6.86964	0
76-75	-0.125941	1.01565	-0.124	0.901346	5.38983	1.0156	5.30704	1.4408E-07

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	5.0854	0.898761	5.65824	2.1240E-08	4.08144	1.79245	2.27702	0.0230462
76-74	4.84935	0.720105	6.73423	0	4.26301	1.43748	2.96562	0.00310974
76-75	2.63194	0.718334	3.66396	0.00026457	5.51577	1.43596	3.84118	0.000132045

NOTE: These results are adjusted to an average age of 26 years. 10 months. All significance levels are based upon a linear model for which s^2 = 61.0737 with 807 degrees of freedom.

TABLE VII.7

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Calories for All Metabolic Ward Participants

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	88.7591	0.525905	89.378	0.516454	89.0686	0.368751	0.618878	0.736676	0.840095	0.401104
74A	89.3103	0.503903	90.5894	0.508241	89.9498	0.358409	1.27911	0.714581	1.79002	0.0738258
74B	87.8288	0.508335	89.2193	0.512564	88.524	0.361558	1.39087	0.720664	1.92983	0.0540278
75A	90.6062	0.504844	91.0274	0.513268	90.8168	0.361035	0.42119	0.71768	0.586877	0.55745
75B	88.6938	0.504856	89.055	0.50881	88.8744	0.359479	0.361173	0.714587	0.505428	0.613396
76A	89.2854	0.50993	92.8886	0.505554	91.087	0.360764	3.60316	0.71458	5.04238	5.6814E-07
76B	89.0523	0.514778	91.785	0.505573	90.4187	0.362663	2.73269	0.717706	3.80753	0.000150996
73	88.7591	0.525905	89.378	0.516454	89.0686	0.368751	0.618878	0.736676	0.840095	0.401104
74Avg	88.5695	0.358473	89.9043	0.361493	89.2369	0.255376	1.33479	0.507438	2.63045	0.00868973
75Avg	89.65	0.358176	90.0412	0.362391	89.8456	0.256324	0.391182	0.506388	0.772494	0.440048
76Avg	89.1689	0.364236	92.3368	0.359181	90.7528	0.258323	3.16792	0.506395	6.25583	0

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	0.409756	0.638066	0.642185	0.520936	2.9588	0.627875	4.7124	.0000028826
76-74	0.599353	0.50801	1.17981	0.238425	2.43248	0.506787	4.79581	.0000018922
76-75	-0.481114	0.50652	-0.949842	0.342477	2.29563	0.506493	4.53239	.0000067143

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	1.68428	0.448224	3.75767	0.00018385	2.54904	0.89392	2.85153	0.00446195
76-74	1.51592	0.359126	4.22113	0.00002707	1.83313	0.716888	2.55706	0.0107378
76-75	0.907256	0.358243	2.53252	0.0115131	2.77674	0.716131	3.87742	0.000114156

NOTE: These results are adjusted to an average age of 26 years, 10 months. All significance levels are based upon a linear model for which $s^2 = 51.0737$ with 807 degrees of freedom.

TABLE VII.8

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Fat for All Metabolic Ward Participants

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	83.6611	0.945725	77.2415	0.928729	80.4513	0.663118	6.41959	1.32475	4.84589	.0000015116
74A	79.6138	0.906159	77.9808	0.91396	78.7973	0.64452	1.63298	1.28502	1.27079	0.20417
74B	80.255	0.914129	79.0198	0.921736	79.6374	0.650193	1.23512	1.29596	0.953061	0.340844
75A	81.619	0.90785	80.2003	0.923	80.9097	0.649349	1.41867	1.29059	1.09924	0.271991
75B	80.5155	0.907872	78.5988	0.914984	79.5571	0.646444	1.91666	1.28503	1.49153	0.136214
76A	91.2674	0.916997	83.1813	0.909128	87.2244	0.648754	8.08612	1.28502	6.29262	0
76B	89.0705	0.925715	83.919	0.909162	86.4947	0.65217	5.1515	1.29064	3.99144	.0000716545
73	77.2415	0.945725	83.6611	0.92872	80.4513	0.663118	6.41959	1.32475	4.84589	.0000015116
74Avg	78.5003	0.644635	79.9344	0.650067	79.2174	0.459237	1.43405	0.912517	1.57154	0.11645
75Avg	79.3996	0.644102	81.0672	0.651681	80.2334	0.460942	1.66766	0.910627	1.83133	0.0674191
76Avg	93.5502	0.654999	90.169	0.645909	86.8596	0.464537	6.61881	0.910641	7.26829	0

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	6.30861	1.18742	5.49807	5.1534E-08	6.50782	1.1291	5.76375	1.1704E-08
76-74	5.04982	0.913548	5.52772	4.3809E-08	10.2386	0.911346	11.2302	0
76-75	4.15059	0.910864	4.55676	.0000059982	9.10173	0.910817	9.99294	0

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	6.40822	0.806032	7.95032	0	0.199214	1.60752	0.123926	0.901405
76-74	7.6422	0.645809	11.8335	0	5.18475	1.28917	4.02179	.0000631782
76-75	6.62616	0.644221	10.2855	0	3.95115	1.2879	3.84464	0.000130228

NOTE: These results are adjusted to an average age of 26 years, 10 months. All significance levels are based upon a linear model for which s^2 = 49.1214 with 807 degrees of freedom.

TABLE VII.9

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Dxylose for All Metabolic Ward Participants

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	19.9437	1.03605	20.6736	1.01743	19.8097	0.72645	1.72996	1.45127	1.19203	0.233601
74A	16.[illegible]514	0.992702	19.1532	1.00125	18.0023	0.706076	2.30177	1.40774	1.63508	0.102423
74B	16.9306	1.00143	19.3036	1.00977	18.1172	0.712279	2.37279	1.41973	1.6713	0.0950564
75A	23.3701	0.994555	22.8111	1.01115	23.0906	0.711366	-0.559003	1.41385	-0.395376	0.69267
75B	23.3695	0.994579	23.0905	1.00237	23.23	0.708183	-0.278931	1.40776	-0.198139	0.842987
76A	19.7235	1.00458	24.1896	0.995955	21.9565	0.710714	4.46603	1.40774	3.17247	0.00156866
76B	19.3441	1.01413	26.4105	0.995992	22.8773	0.714456	7.06641	1.4139	4.99782	7.11302-07
73	19.9437	1.03605	20.6736	1.01743	19.8097	0.72645	1.72996	1.45127	1.19203	0.233601
74Avg	16.8911	0.706201	19.2294	0.712152	18.0597	0.503097	2.33728	0.999667	2.33806	0.0196277
75Avg	23.3698	0.705617	22.9508	0.71392	23.1603	0.504964	-0.418967	0.997597	-0.419976	0.674615
76Avg	19.5338	0.717555	25.3	0.707597	22.4169	0.508903	5.76622	0.997613	5.78002	1.0667E-08

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	0.59014	1.25701	0.46948	0.638853	4.6264	1.23693	3.74023	0.000196853
76-74	2.64272	1.00079	2.64362	0.00843532	6.07166	0.998385	6.08146	0
76-75	-3.83599	0.997857	-3.84423	0.000130441	2.34919	0.997805	2.35436	0.0187934

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	2.60827	0.883013	2.95383	0.00322972	4.03626	1.76105	2.29197	0.022164
76-74	4.35719	0.707498	6.15867	0	3.42894	1.41229	2.42793	0.0154029
76-75	-0.743402	0.705748	-1.05335	0.292494	6.18[illegible]19	1.4108	4.38418	.0000131822

NOTE: These results are adjusted to an average age of 26 years, 10 months. All significance levels are based upon a linear model for which s^2 = 58.9523 with 807 degrees of freedom.

TABLE VII.10

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Nitrogen for Longitudinal Sample Subjects Only

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	73.5066	1.34859	77.3453	1.2237	75.426	0.911048	3.83866	1.81996	2.1092	0.035377
74A	77.1619	1.35009	79.0499	1.226	78.1054	0.913699	1.88695	1.81996	1.03681	0.30028
74B	72.9422	1.35009	76.1069	1.23969	74.5246	0.919282	3.16468	1.82925	1.73008	0.0841824
75A	78.4294	1.35275	81.5772	1.25835	80.0033	0.927573	3.14777	1.83906	1.71162	0.0875284
75B	74.1704	1.35275	76.8276	1.24345	75.499	0.922786	2.6572	1.82928	1.45259	0.146904
76A	77.5174	1.37474	85.0452	1.23482	81.2813	0.930909	7.52776	1.83385	4.10489	.0000465619
76B	76.443	1.39646	84.1447	1.23496	80.2938	0.939982	7.70172	1.84816	4.16723	.0000357853
73	73.5066	1.34859	77.3453	1.2237	75.426	0.911048	3.83866	1.81996	2.1092	0.035377
74Avg	75.0521	0.956041	77.5779	0.874228	76.315	0.65034	2.52583	1.29027	1.95758	0.0507829
75Avg	76.2999	0.954792	79.2024	0.849775	77.7511	0.660189	2.90248	1.29707	2.23771	0.0256378
76Avg	76.9802	0.986189	84.5949	0.881847	80.7876	0.671881	7.61474	1.30182	5.84929	8.4559E-09

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	3.47355	1.66738	2.08325	0.0376883	7.24963	1.5019	4.82598	.0000017968
76-74	1.92812	1.3651	1.41246	0.158384	7.01704	1.22864	5.71125	1.8334E-08
76-75	0.680303	1.36319	0.499053	0.617941	5.39256	1.23356	4.37154	.0000147466

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	5.36159	1.12531	4.76453	.0000024232	3.77608	2.23749	1.69764	0.0920448
76-74	4.47258	0.92021	4.86039	.0000015291	5.08892	1.83274	2.77668	0.00567822
76-75	3.03643	0.919721	3.30147	0.00102396	4.71226	1.83749	2.56451	0.0105956

NOTE: These results are adjusted to an average age of 25 years, 10 months. All significance levels are based upon a linear model for which $s^2 = 67.2463$ with 552 degrees of freedom.

TABLE VII.11

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Calories for Longitudinal Sample Subjects Only

ear and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	88.5169	0.649514	89.5327	0.589367	89.0248	0.438783	1.01578	0.876538	1.15886	0.247015
74A	88.6611	0.650238	90.6213	0.590471	89.6412	0.44006	1.96015	0.876539	2.23624	0.025735
74B	87.5679	0.650238	89.3602	0.597088	88.464	0.442268	1.79226	0.891015	2.03432	0.0423971
75A	90.1983	0.651517	91.456	0.606046	90.8271	0.446935	1.25768	0.895736	1.41993	0.156198
75B	88.1479	0.65152	89.1842	0.588865	88.6661	0.444418	1.03627	0.881026	1.1762	0.240021
76A	89.6757	0.662108	92.9541	0.594721	91.3149	0.448349	3.27846	0.883228	3.71191	0.000226566
76B	88.9642	0.67257	91.8588	0.594741	90.4115	0.452719	2.89662	0.890122	3.25194	0.00121617
73	88.5169	0.649514	89.5327	0.589367	89.0248	0.438783	1.01578	0.876538	1.15886	0.247015
74Avg	88.1145	0.460453	89.7907	0.42105	89.0526	0.31322	1.87621	0.621929	3.01918	0.00265172
75Avg	89.1731	0.46226	90.3201	0.428538	89.7466	0.317963	1.14697	0.628704	1.83603	0.0668913
76Avg	89.3199	0.474973	92.4065	0.42872	90.8632	0.323595	3.08658	0.626991	4.92279	.0000011284

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	0.803021	0.80305	0.999963	0.317766	2.87378	0.723352	3.97287	0.000080429
76-74	1.20541	0.657465	1.83343	0.067277	2.41575	0.591702	4.08244	.0000511537
76-75	0.146821	0.656546	0.223626	0.823131	2.08639	0.594114	3.51177	0.000461557

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	1.8389	0.541979	3.39201	0.000743517	2.07076	1.07763	1.92159	0.0551724
76-74	1.81058	0.443196	4.08529	.0000505494	1.21038	0.882692	1.37119	0.170673
76-75	1.11661	0.442961	2.52078	0.0119902	1.93957	0.864981	2.19169	0.0288216

NOTE: These results are adjusted to an average age of 26 years, 10 months. All significance levels are based upon a linear model for which $s^2 = 15.5986$ with 552 degrees of freedom.

TABLE VII.12

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption of Fat For Longitudinal Sample Subjects Only

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	76.458	1.14164	83.2394	1.03592	79.8467	0.771244	6.78541	1.54068	4.40416	.0000127575
74A	76.9714	1.14292	80.0385	1.03786	78.505	0.773489	3.06708	1.54068	1.99073	0.0470034
74B	78.9014	1.14292	80.7632	1.04945	79.8323	0.777368	1.86176	1.54855	1.20226	0.229778
75A	79.4232	1.14516	82.5079	1.06524	80.9656	0.785572	3.0847	1.55685	1.98138	0.0480465
75B	77.9966	1.14517	81.132	1.05262	79.5643	0.781148	3.13538	1.54857	2.0247	0.0433794
76A	83.6181	1.16378	90.5303	1.04533	87.0742	0.788058	6.91225	1.55244	4.45251	.0000102752
76B	83.8296	1.18217	88.2609	1.04537	86.0452	0.795739	4.43131	1.56856	2.83231	0.00479001
73	76.458	1.14164	83.2394	1.03592	79.8467	0.771244	6.78541	1.54068	4.40416	.0000127575
74Avg	77.9358	0.809333	80.4008	0.740075	79.1686	0.550543	2.46442	1.09728	2.25622	0.0244473
75Avg	78.7099	0.812508	81.82	0.753236	80.2649	0.55888	3.11004	1.09903	2.83237	0.00474909
76Avg	83.7238	0.834855	89.3956	0.746525	86.5597	0.568779	5.67178	1.10285	5.14655	3.6939E-07

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	7.26983	1.41151	5.15038	3.62268-07	6.1562	1.27143	4.84196	.0000016716
76-74	5.78741	1.15562	5.00807	7.4093E-07	8.99477	1.0801	8.68801	0
76-75	5.01391	1.154	4.3448	.0000165985	7.57565	1.04427	7.25452	0

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	6.71301	0.952631	7.04681	0	-1.11363	1.89414	-0.587935	0.556816
76-74	7.39109	0.779801	9.48792	0	3.20736	1.5515	2.06727	0.0391703
76-75	6.29478	0.778587	8.08088	0	2.56178	1.55552	1.64687	0.100158

NOTE: These results are adjusted to an average age of 26 years, 10 months. All significance levels are based upon a linear model for which s^2 = 48.1915 with 552 degrees of freedom.

TABLE VII.13

Summary of Four Years of Detailed Absorption Studies For Percentage Absorption Dxylose For Longitudinal Sample Subjects Only

Year and Balance	FLORIDA ACEITUNO (FA)		GUANAGAZAPA (GU)		Average: FA & GU		Difference: GU - FA			
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	t	sig
73	18.4672	1.2115	20.8268	1.09931	19.647	0.818038	2.35953	1.63495	1.44318	0.149537
74A	18.2107	1.21285	19.3294	1.10137	18.7695	0.820816	1.11767	1.53995	0.683611	0.494501
74B	18.2107	1.21285	19.8983	1.11367	19.0545	0.824933	1.68762	1.6433	1.02697	0.304883
75A	22.2581	1.21523	24.1086	1.13042	23.1913	0.833639	1.8485	1.65211	1.11766	0.264197
75B	22.2579	1.21524	23.5429	1.11702	22.9004	0.829943	1.28494	1.64332	0.781917	0.434599
76A	20.725	1.23899	26.479	1.10929	23.602	0.836277	5.75396	1.64743	3.49269	0.000516496
76B	19.7378	1.2545	27.4023	1.10933	23.57	0.844427	7.66445	1.66029	4.61636	.0000048626
73	18.4672	1.2115	20.8268	1.09931	19.647	0.818034	2.35953	1.63495	1.44318	0.149537
74Avg	18.2107	0.858853	19.6133	0.785358	18.912	0.584229	1.40265	1.15911	1.21011	0.226756
75Avg	22.258	0.862223	23.8237	0.799124	23.0408	0.593077	1.56572	1.16522	1.34371	0.179593
76Avg	20.2314	0.885937	26.9406	0.792202	23.586	0.603581	6.7092	1.16949	5.73699	1.5896E-08

	Florida Aceituno (FA)				Guanagazapa (GU)			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	1.76417	1.49788	1.17778	0.239392	6.11394	1.38922	4.53139	.0000071878
76-74	2.02072	1.22633	1.64778	0.099966	7.32728	1.10374	6.6396	0
76-75	-2.02658	1.22461	-1.65487	0.0985187	3.1169	1.10816	2.81268	0.00508795

	Average: FA & GU				Difference: GU - FA			
	Mean	S.E.	t	sig	Mean	S.E.	t	sig
76-73	3.93901	1.01092	3.89696	0.000109591	4.34968	2.01003	2.16398	0.030898
76-74	4.674	0.926665	5.65804	2.5151E-08	5.30656	1.64643	3.22307	0.00134309
76-75	0.545163	0.826226	0.659823	0.509642	5.13348	1.6507	3.11595	0.00192837

NOTE: These results are adjusted to an average age of 26 years, 10 months. All significance levels are based upon a linear model for which $s^2 = 54.2692$ with 592 degrees of freedom.

was used in computing all the significance levels.

4. Description of the Figures

Figures VII.2 to VII.9 illustrate many of the statistics presented in Table VII.6 to VII.13. The following list is a guide to compare the tables and figures:

Table	Figure	Percent Absorption of	Group
6	2	Nitrogen	All subjects
7	3	Calories	All subjects
8	4	Fat	All subjects
9	5	d-Xylose	All subjects
10	6	Nitrogen	Longitudinal subjects
11	7	Calories	Longitudinal subjects
12	8	Fat	Longitudinal subjects
13	9	d-Xylose	Longitudinal subjects

In each figure, the vertical axis represents percentage absorption of the indicated component (nitrogen, calories, fat, or d-Xylose). The years of the study are indicated on the horizontal axis. The data for the single balance in 1973 are plotted above the year designation "73". The data for the first balance in 1974 are plotted above the label "74.1" and the data for the second balance are plotted above the label "74.2". Similarly, 75.1 and 75.2, 76.1 and 76.2 were used to indicate the pairs of balances in 1975 and 1976.

There are six symbols which are plotted to give information about variables for each balance. The "F" symbol for a specified balance represents the age-adjusted mean percent absorption for subjects from Florida Aceituno. The numical value of the plotted symbol may be found i .he first column of the first panel of the corresponding table. A

"+" is plotted one standard error above the "F" and a "-" is plotted one standard error below the "F". Similarly, the "G" for a particular balance represents the age-adjusted mean for subjects from Guanagazapa and the numerical value is found in the third column of the first panel of the corresponding Table.

Figure VII.2 is taken as an example. The Guanagazapa subjects absorbed an average of 77.1% of ingested nitrogen. The number 77.1 comes from Table VII.6 and the corresponding "G" is plotted above the 73 (year) value on the horizontal axis and just below the 78 "tic mark" on the vertical axis. The "+ sign" immediately above the "G" and the "- sign" immediately below the "G" indicate the mean plus and minus one standard error. The mean percent absorption of nitrogen for subjects from Florida Aceituno was much lower at the 74.1% level. In this case, the "-" for Guanagazapa is substantially above the "+" for Florida Aceituno. The graph should not be interpreted in terms of significance unless the intervals overlap which indicates non-significance. The corresponding table gives the comparison of the two village means and the corresponding 5-test value and significance level.

5. Description of the Histograms

Histograms are a convenient method for illustrating the results of the detailed absorption studies. A number of histograms have been prepared which illustrate the comparisons between villages and among years, as well as comparisons with the so-called "reference population" of soldiers from the Mariscal Zavala army post who were extensively studied in 1974 (see Section VI). The following is a guide for locating and relating the histograms which are numbered as specified:

FIGURE VII.2

Percentage Absorption of Nitrogen
(Four Years of Metabolic Studies - All Subjects)

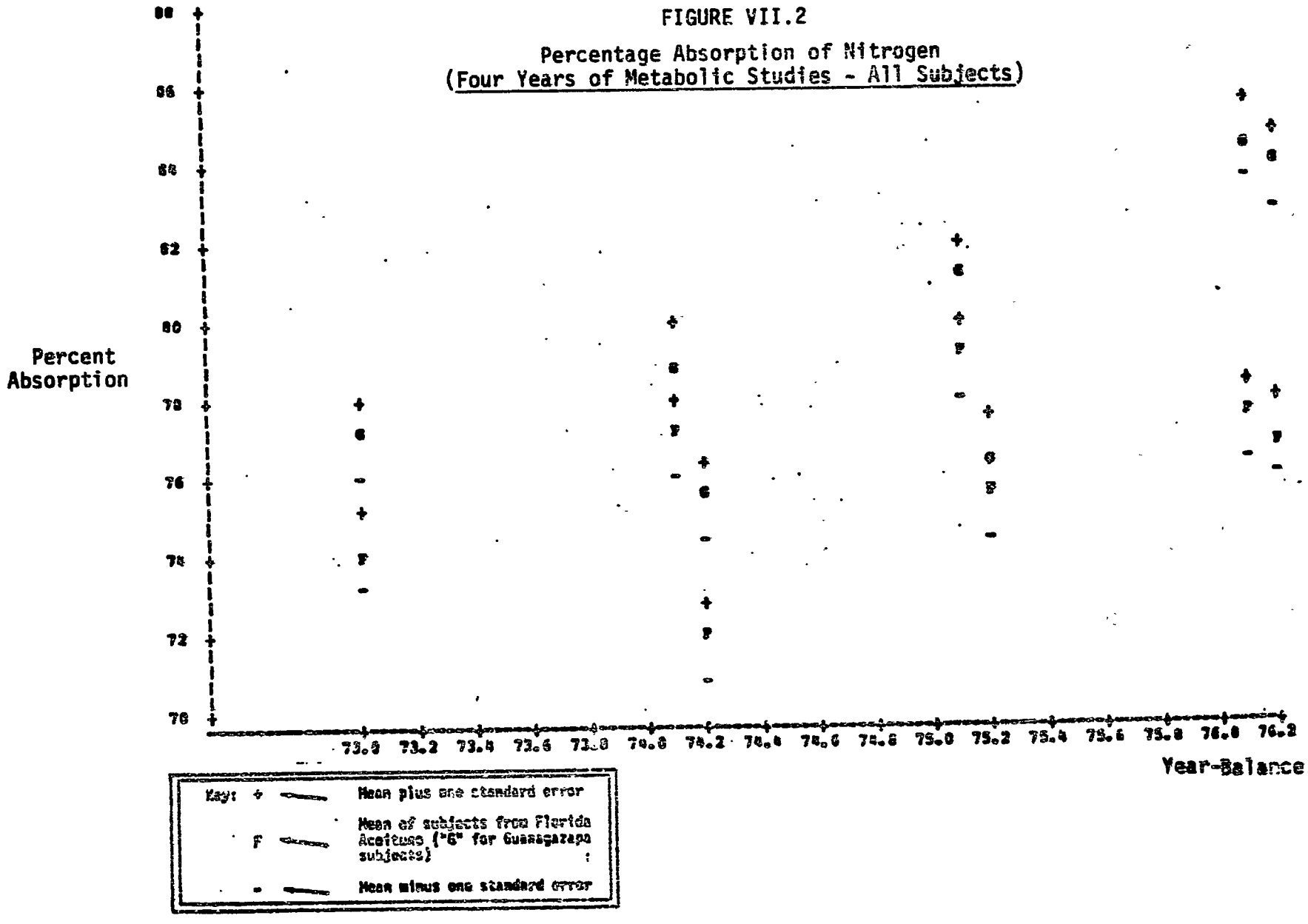


FIGURE VII.3

Percentage Absorption of Calories.
(Four Years of Metabolic Studies - All Subjects)

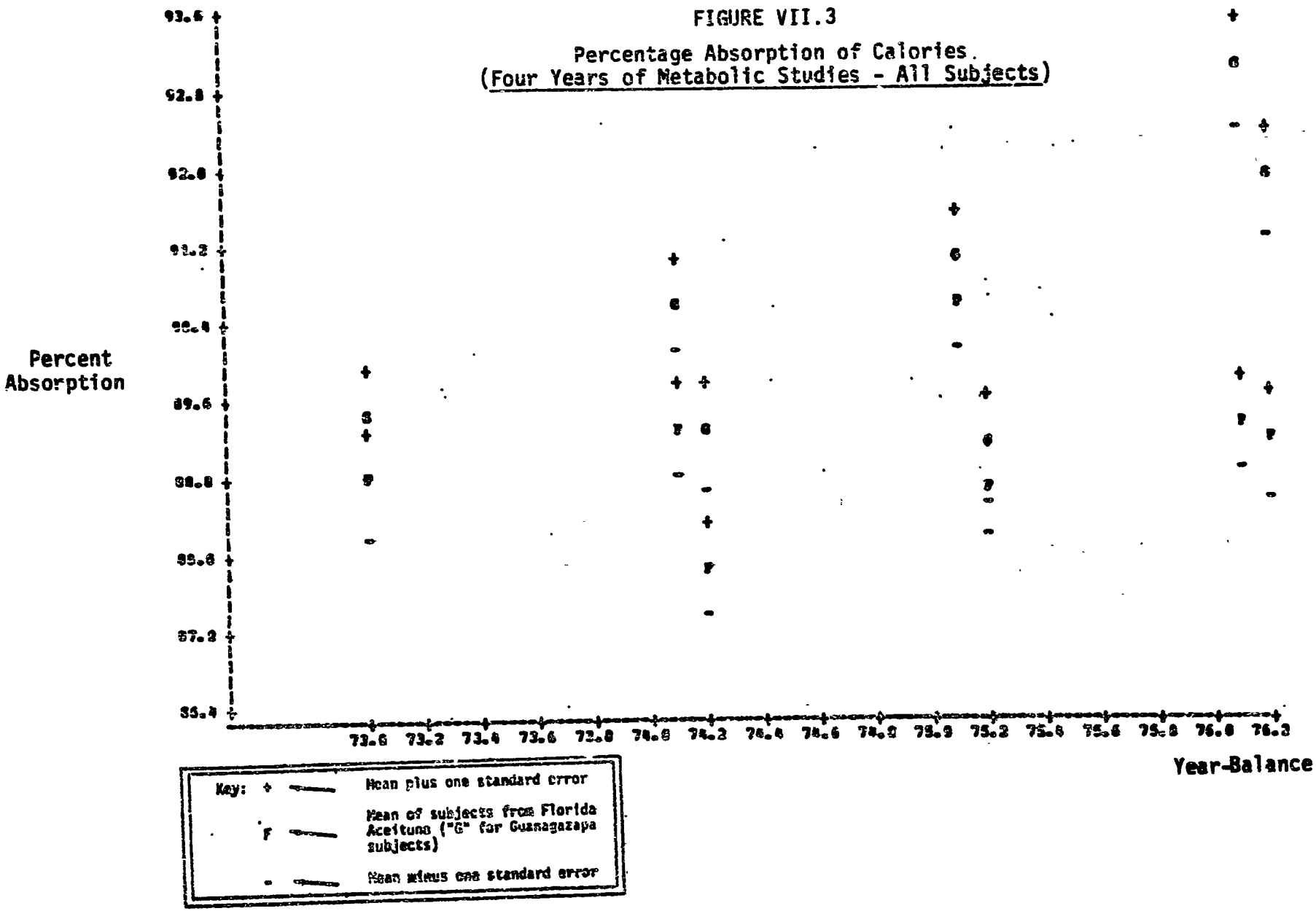


FIGURE VII.4

Percentage Absorption of Fat
(Four Years of Metabolic Studies - All Subjects)

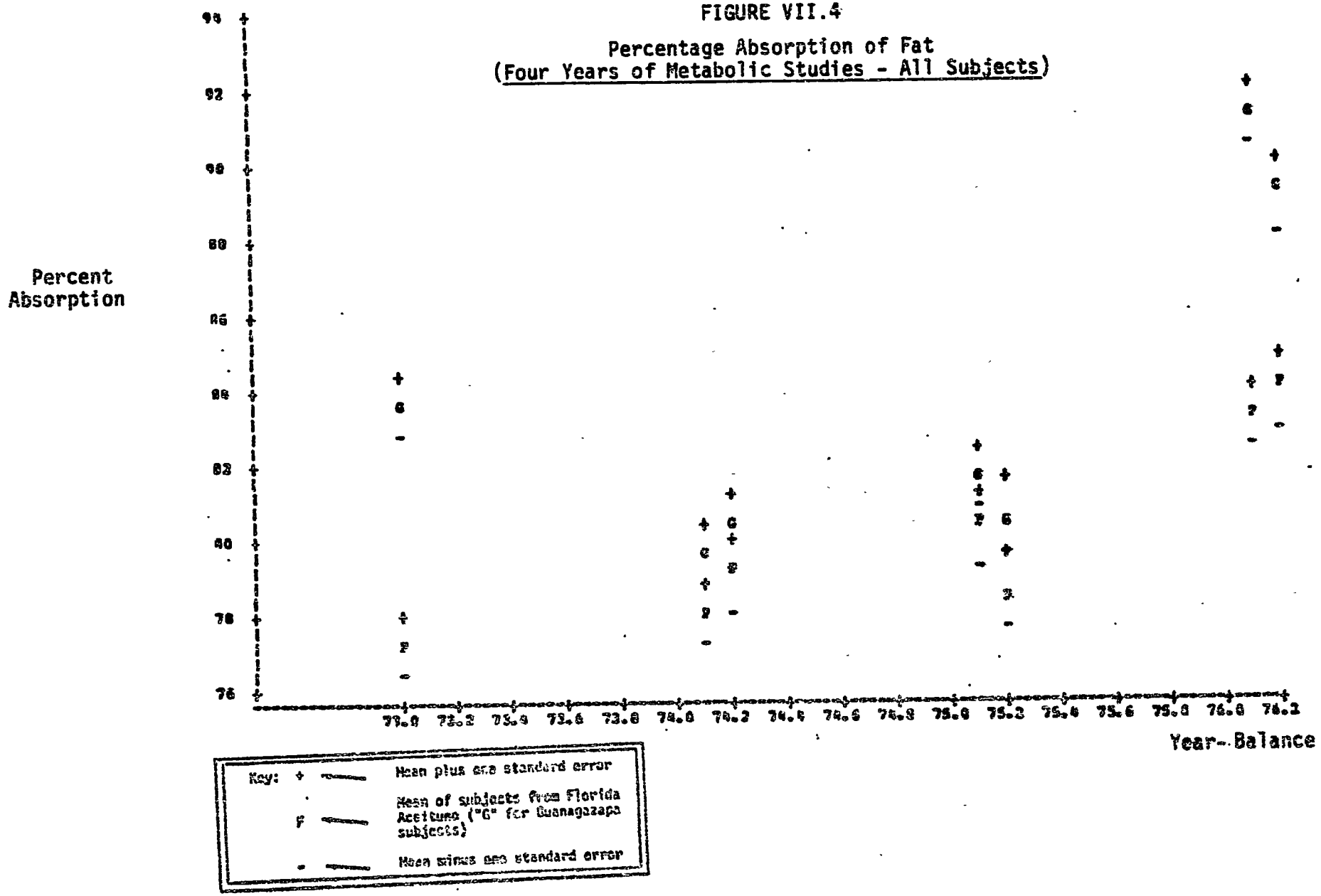


FIGURE VII.5

Percentage Absorption of d-Xylose
(Four Years of Metabolic Studies - All Subjects)

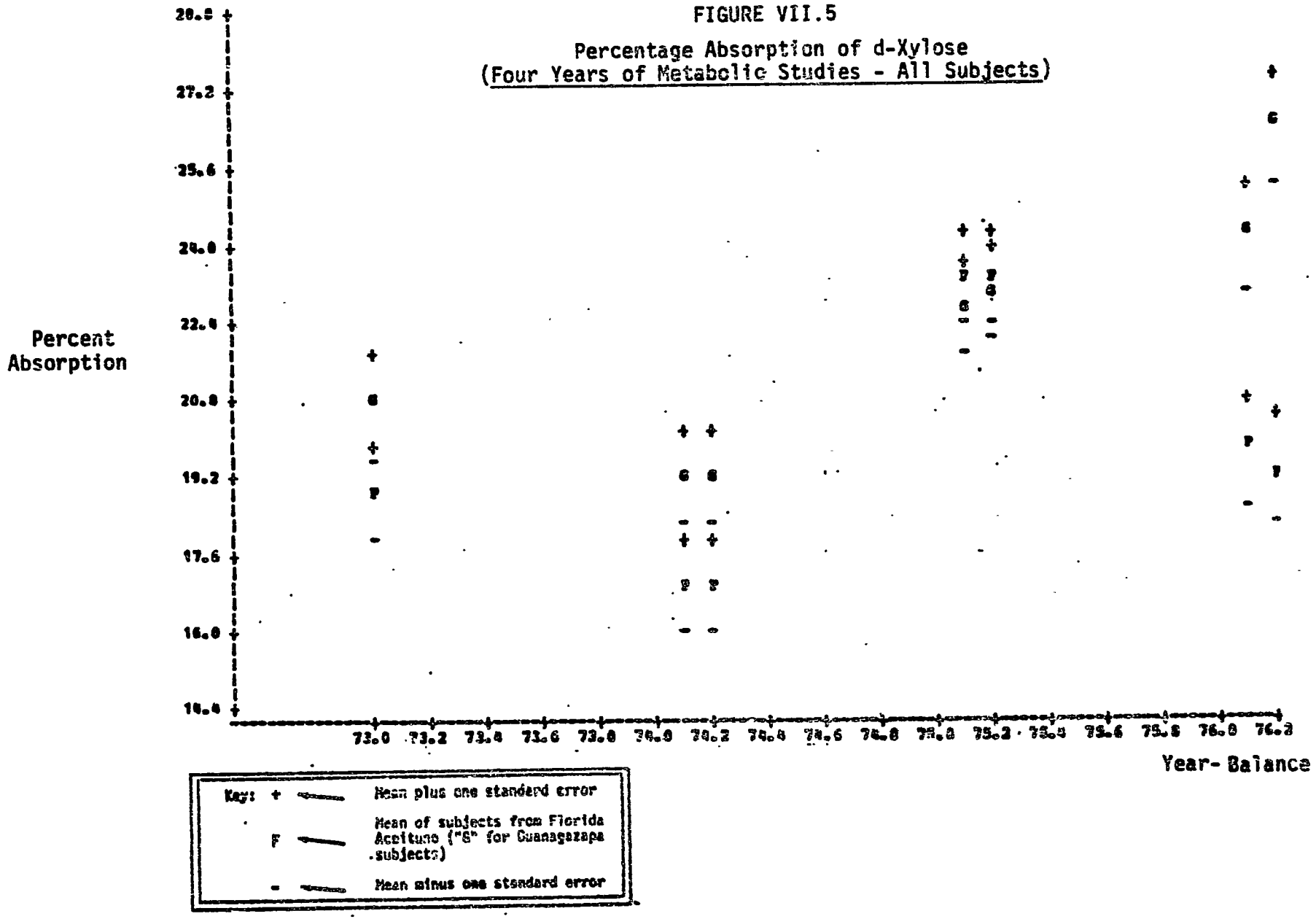


FIGURE VII.6

Percentage Absorption of Nitrogen
(Four Years of Metabolic Studies - Longitudinal Sample Subjects)

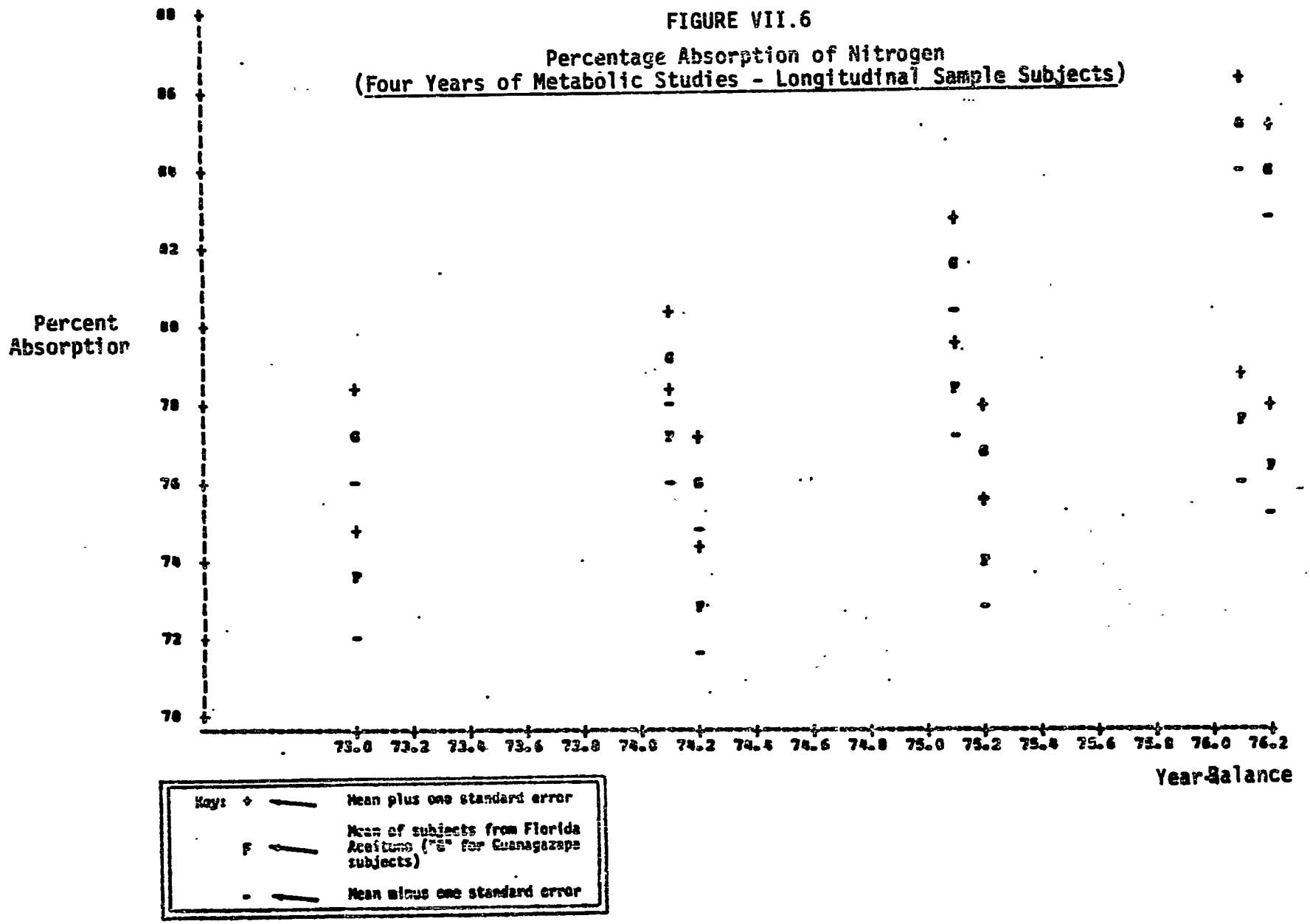


FIGURE VII.7

Percentage Absorption of Calories
(Four Years of Metabolic Studies - Longitudinal Sample Subjects)

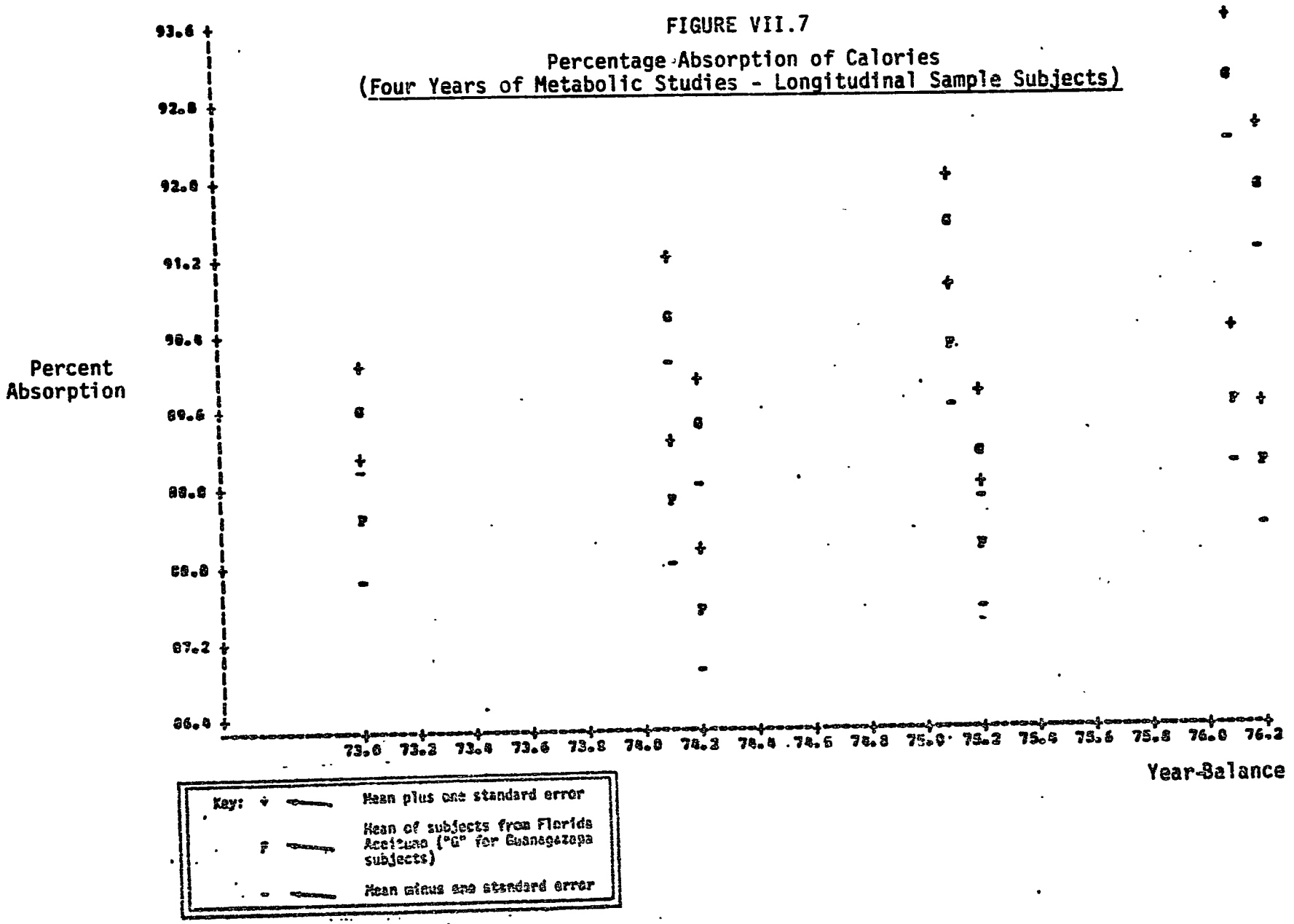


FIGURE VII.8

Percentage Absorption of Fat
(Four Years of Metabolic Studies - Longitudinal Sample Subjects)

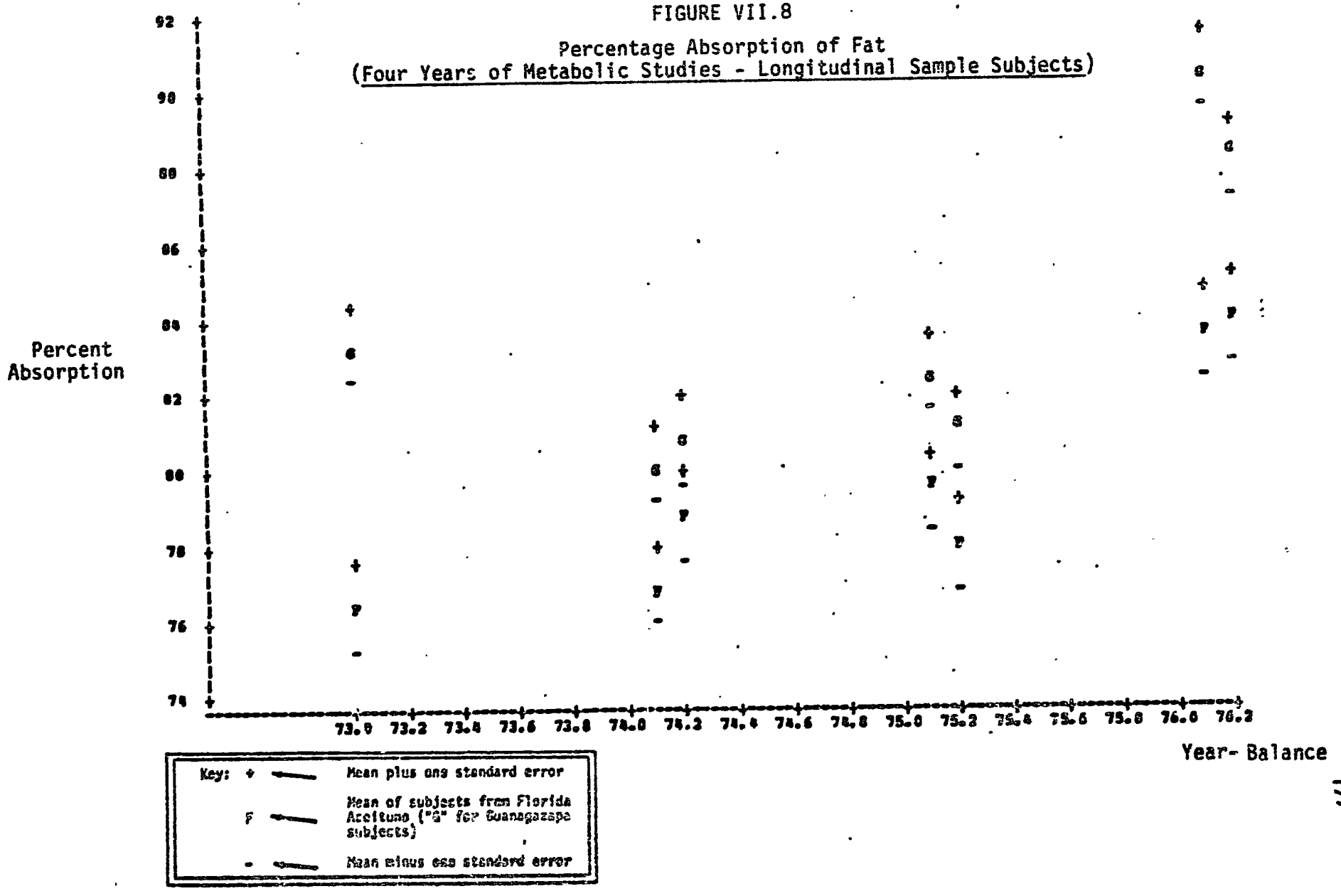
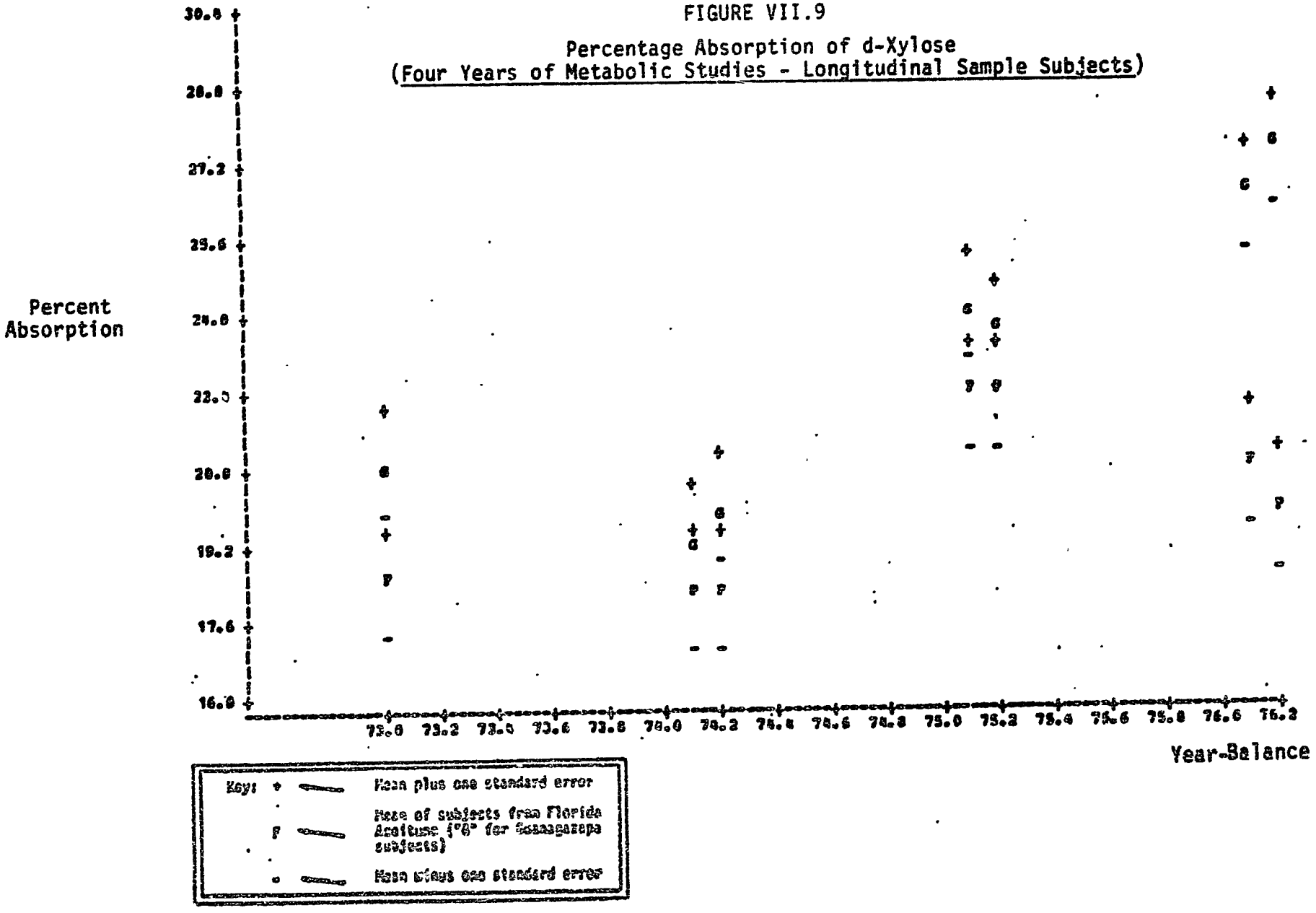


FIGURE VII.9

Percentage Absorption of d-Xylose
(Four Years of Metabolic Studies - Longitudinal Sample Subjects)



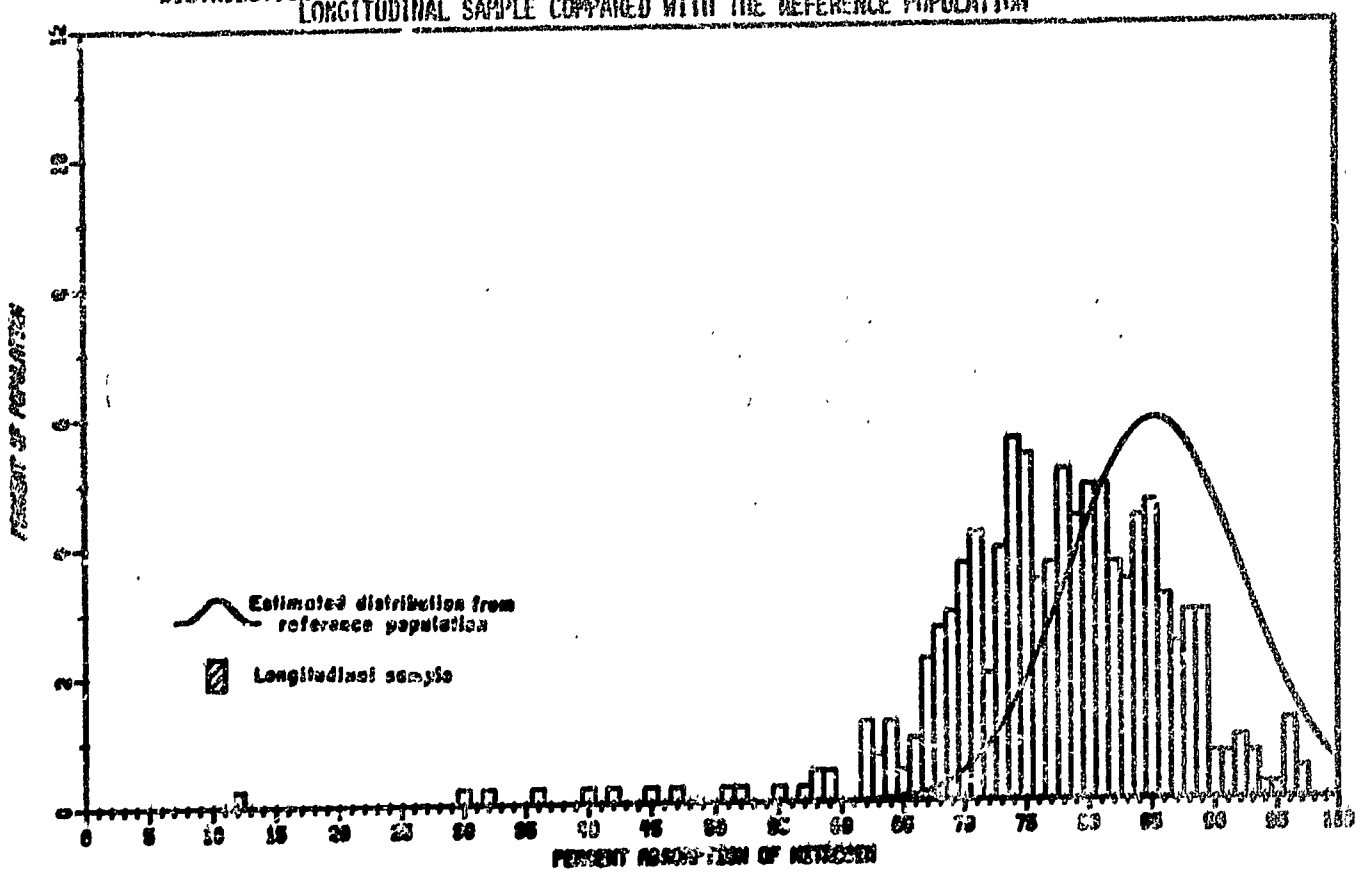
Location of Histograms of Detailed Absorption

Years Represented	Village	Histogram Numbers For		
		Nitrogen	Calories	Fat
73-76	FA	01	15	29
73-76	GU	02	16	30
73	FA	03	17	31
73	GU	04	18	32
74	FA	05	19	33
74	GU	06	20	34
75	FA	07	21	35
75	GU	08	22	36
76	FA	09	23	37
76	GU	10	24	38
73	BOTH	11	25	39
74	BOTH	12	26	[illegible]
75	BOTH	13	27	41
76	BOTH	14	28	42
73-76	BOTH	43	44	45

The first step in the production of the histograms was to round off each subject's percentage absorption value of nitrogen, calories or fat to the nearest whole percent. The proportion of subjects for each of these values was computed and plotted in standard histogram style.

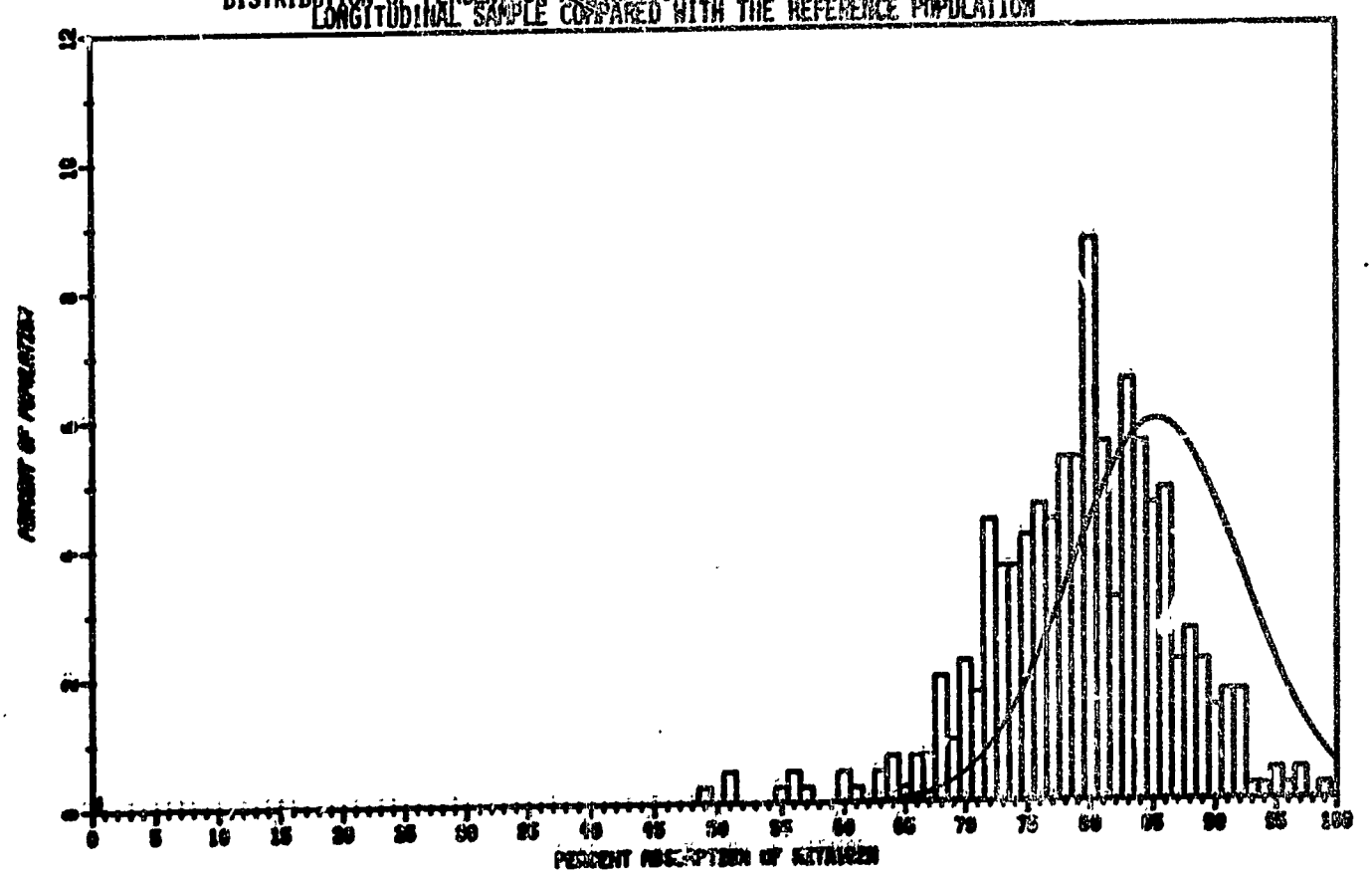
HISTOGRAM VII.1

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1973-76 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



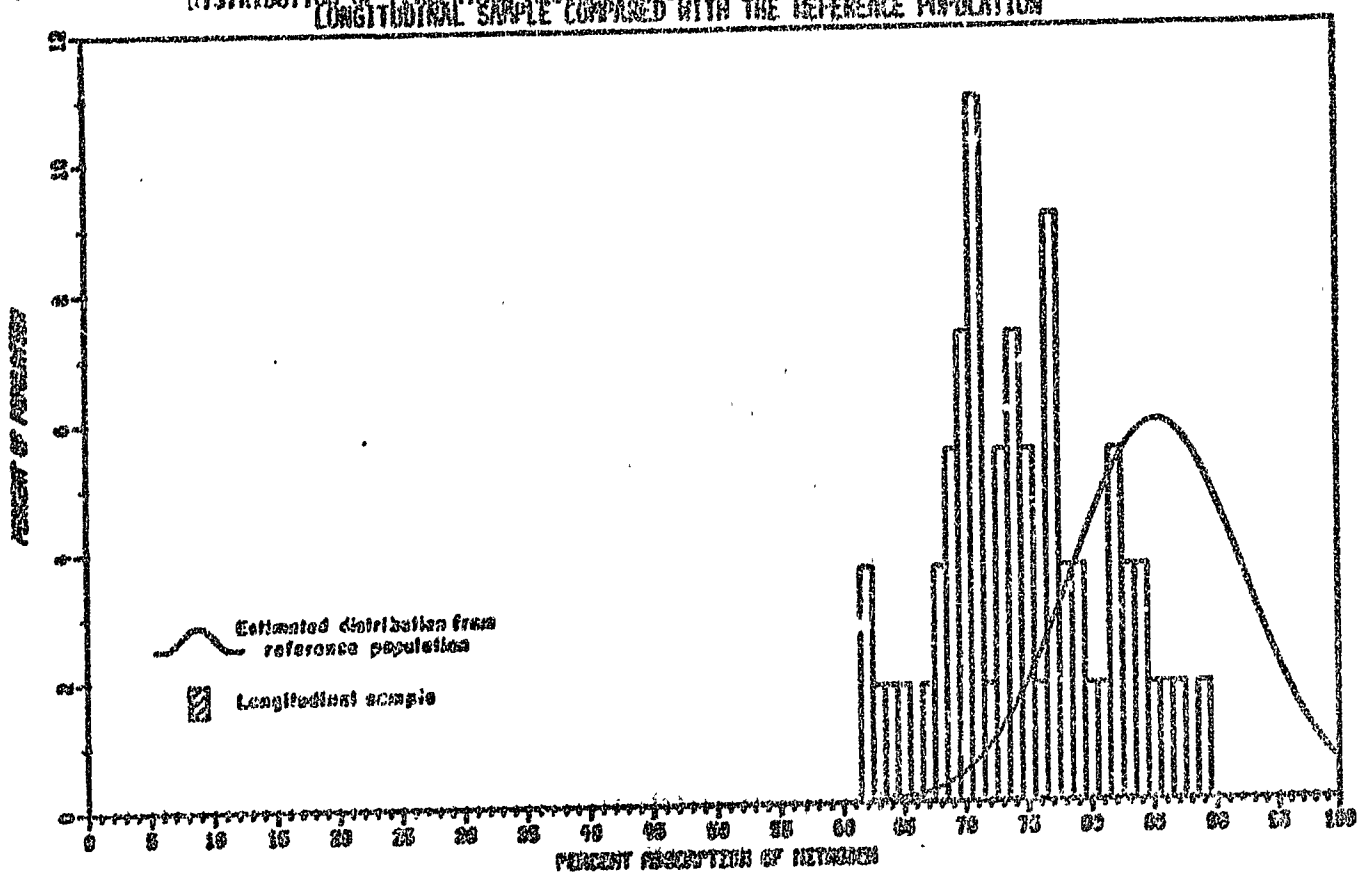
HISTOGRAM VII.2

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1973-76 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



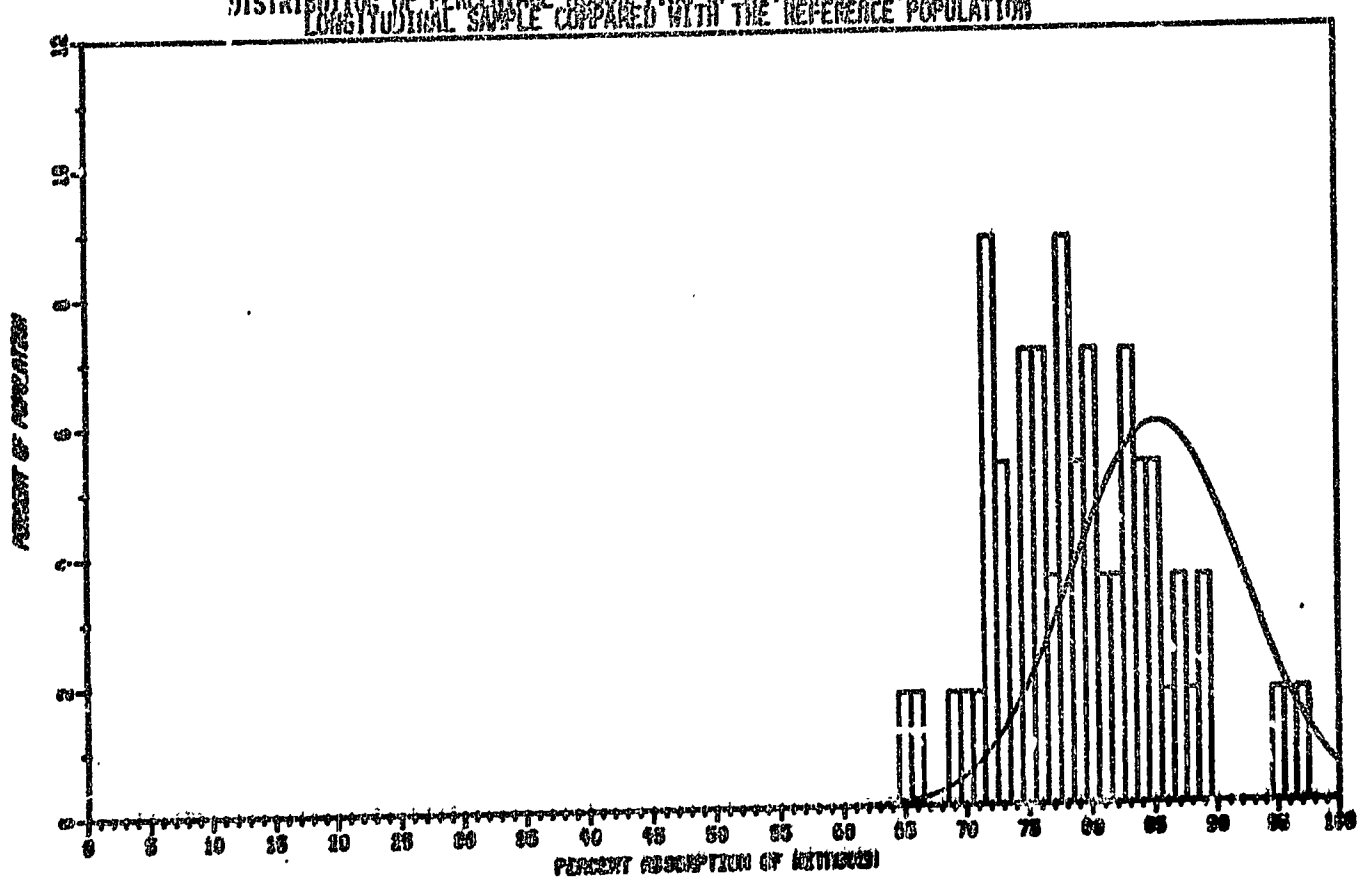
HISTOGRAM VII.3

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1973 FLORUM ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



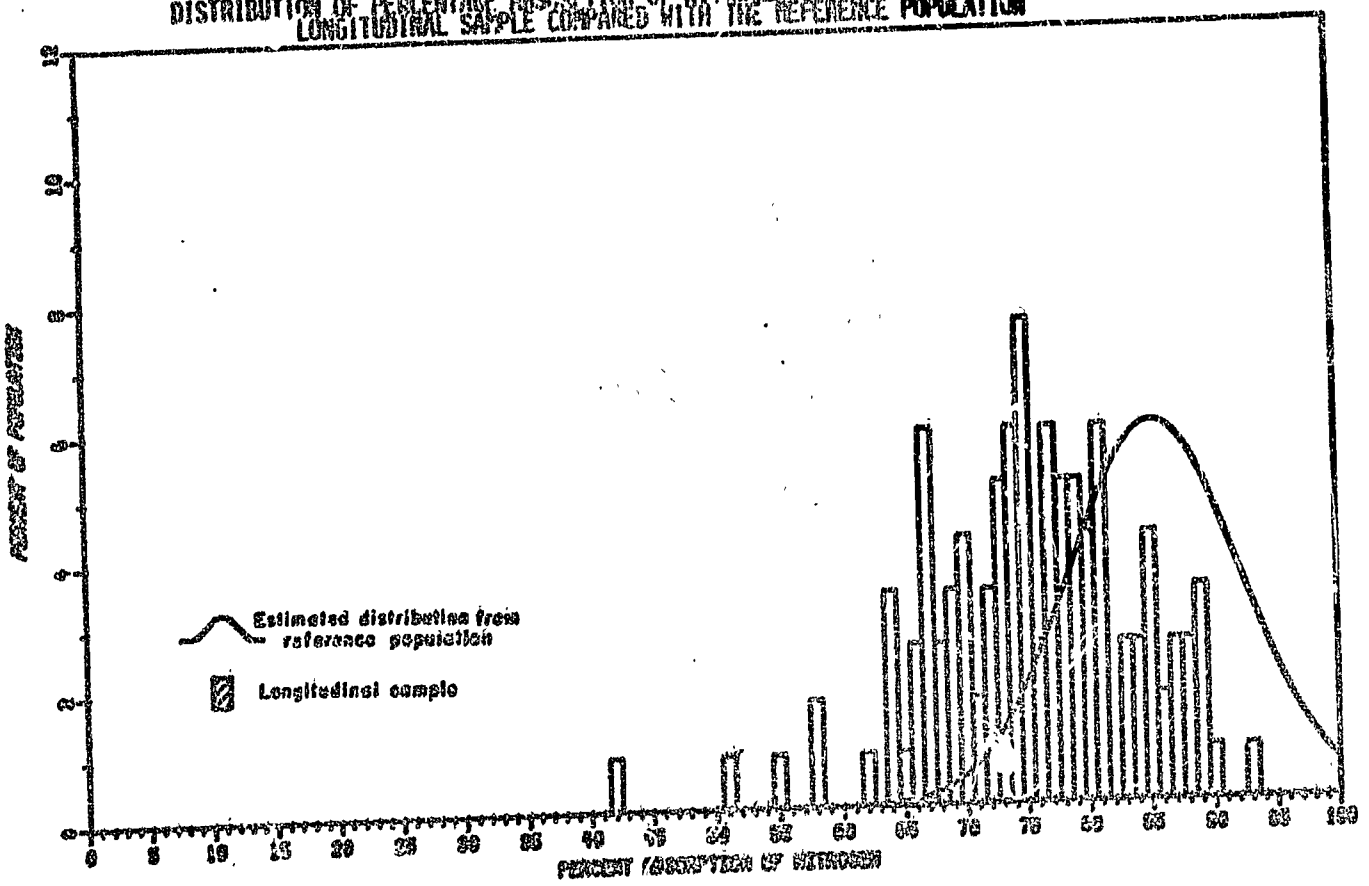
HISTOGRAM VII.4

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1973 GUAMAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



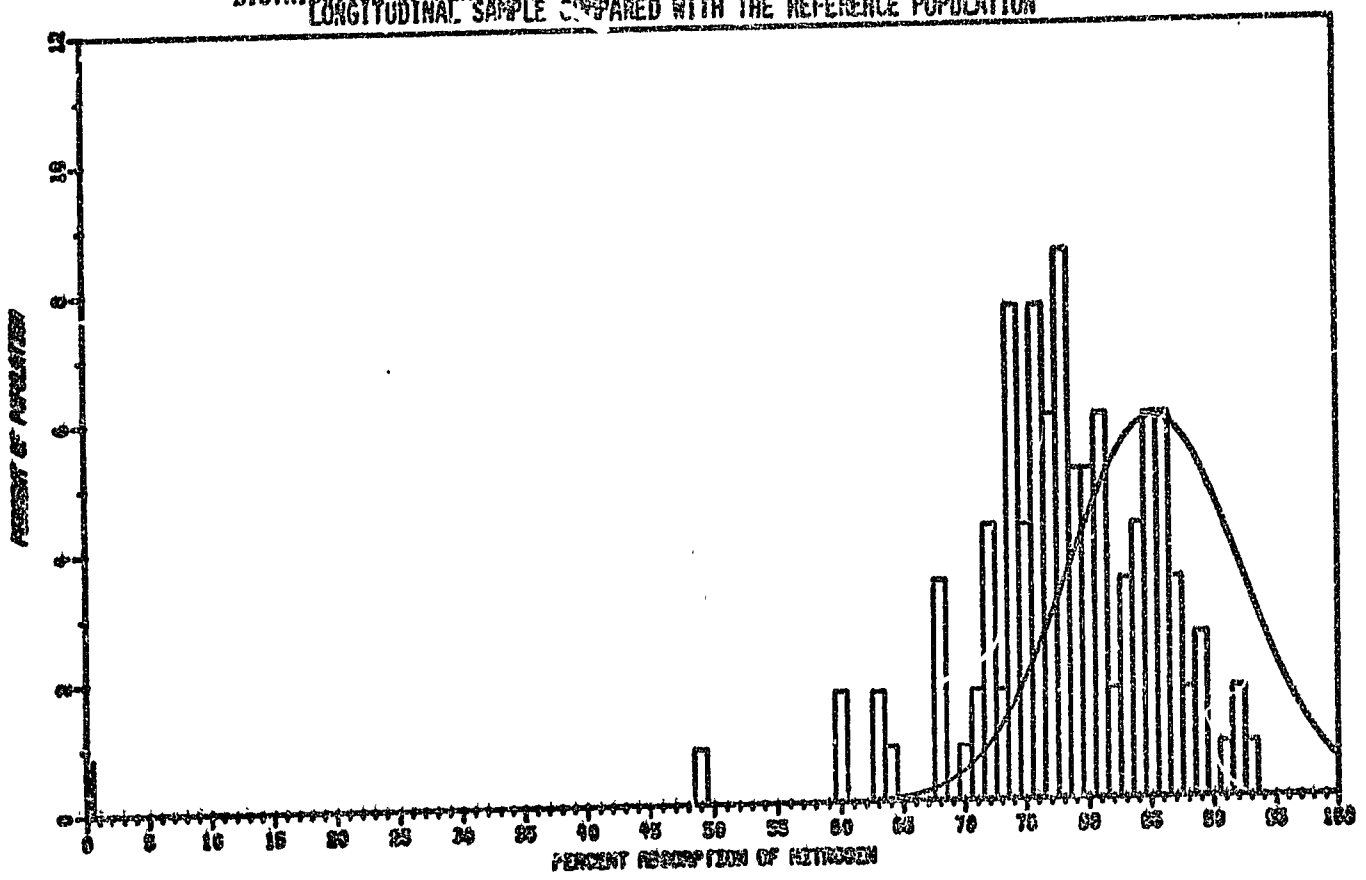
HISTOGRAM VII.5

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1974 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION

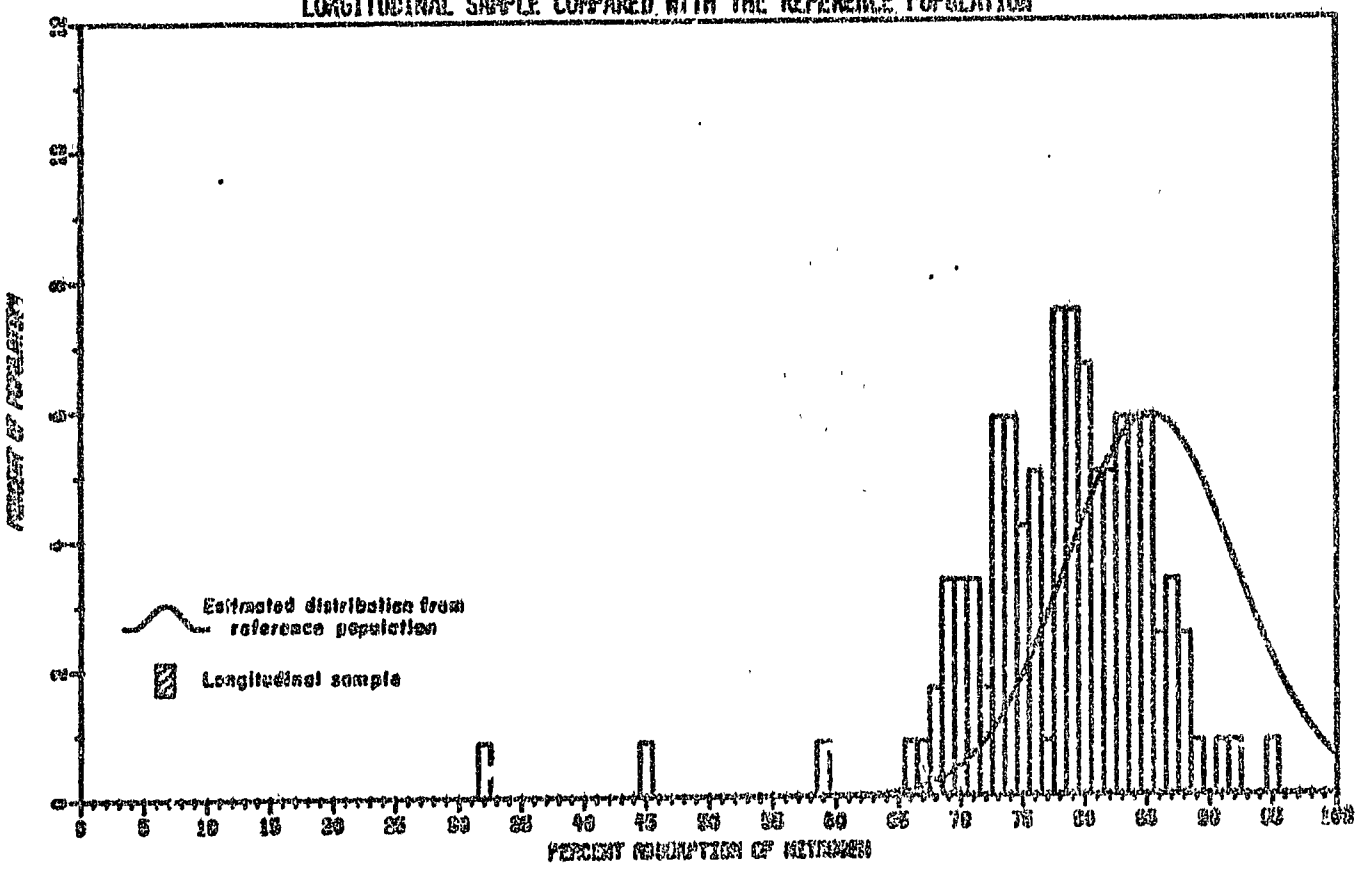


HISTOGRAM VII.6

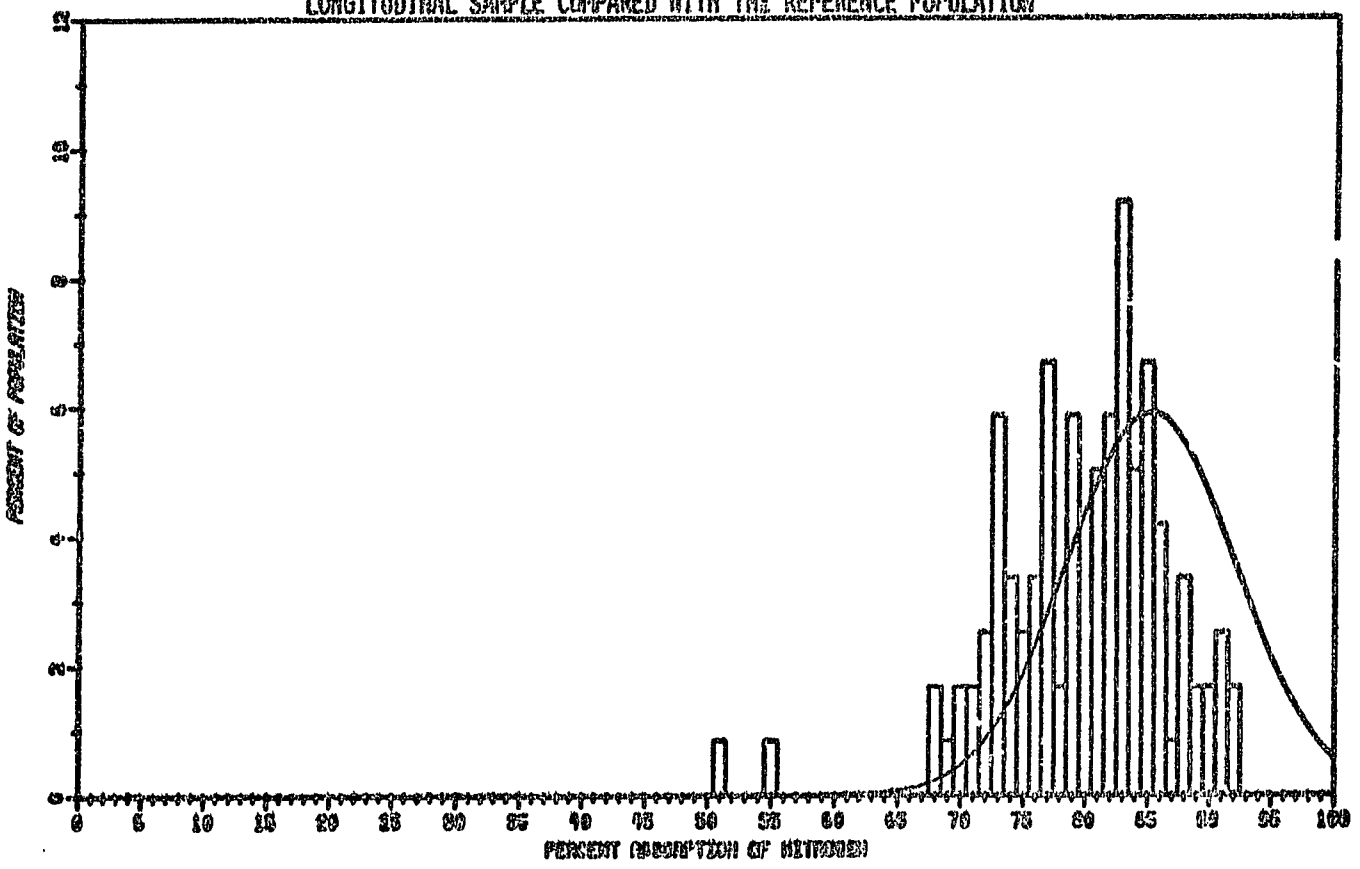
DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1974 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



HISTOGRAM VII.7
DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1975 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION

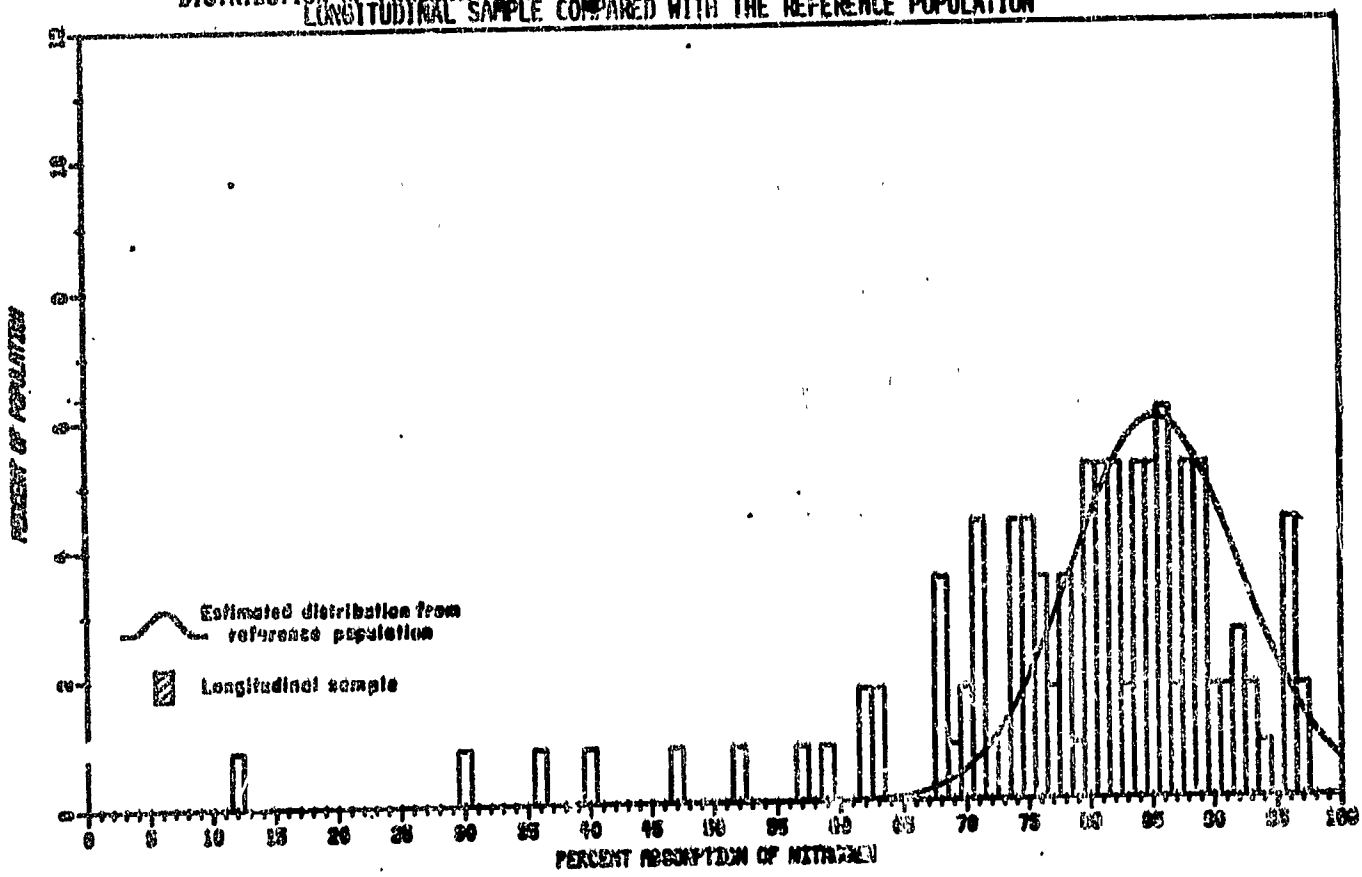


HISTOGRAM VII.8
DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1975 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



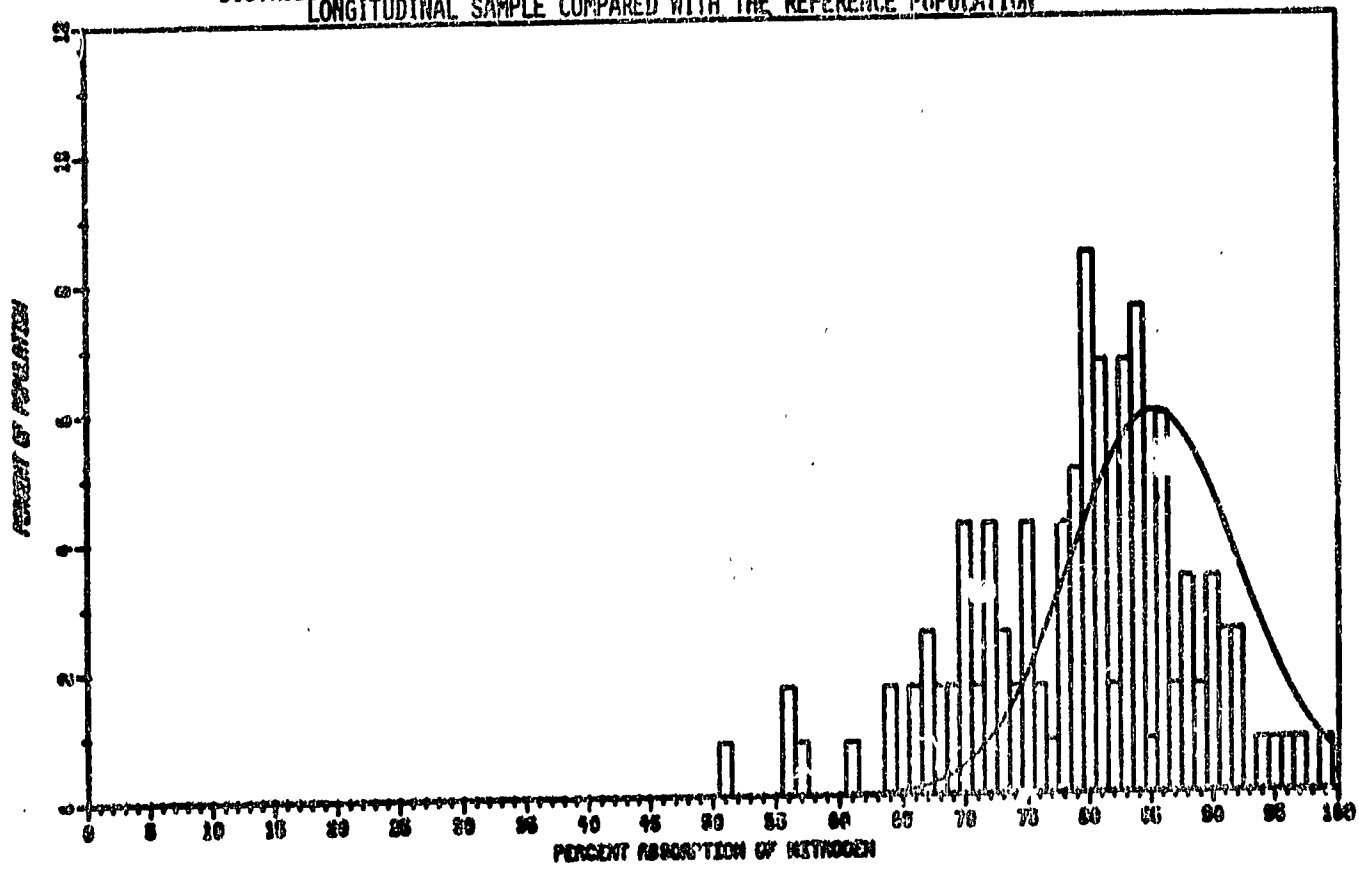
HISTOGRAM VII.9

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1976 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



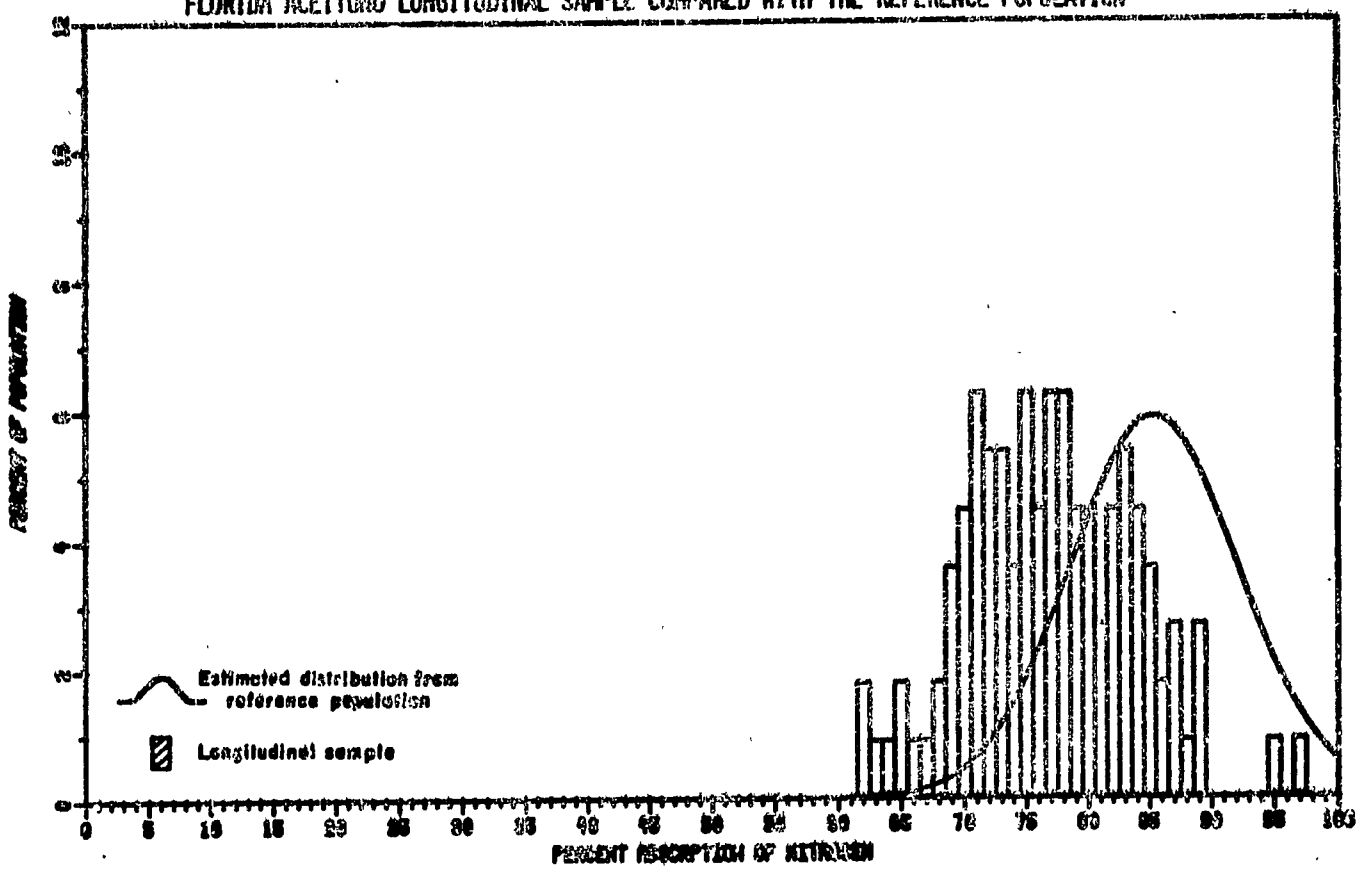
HISTOGRAM VII.10

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1976 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



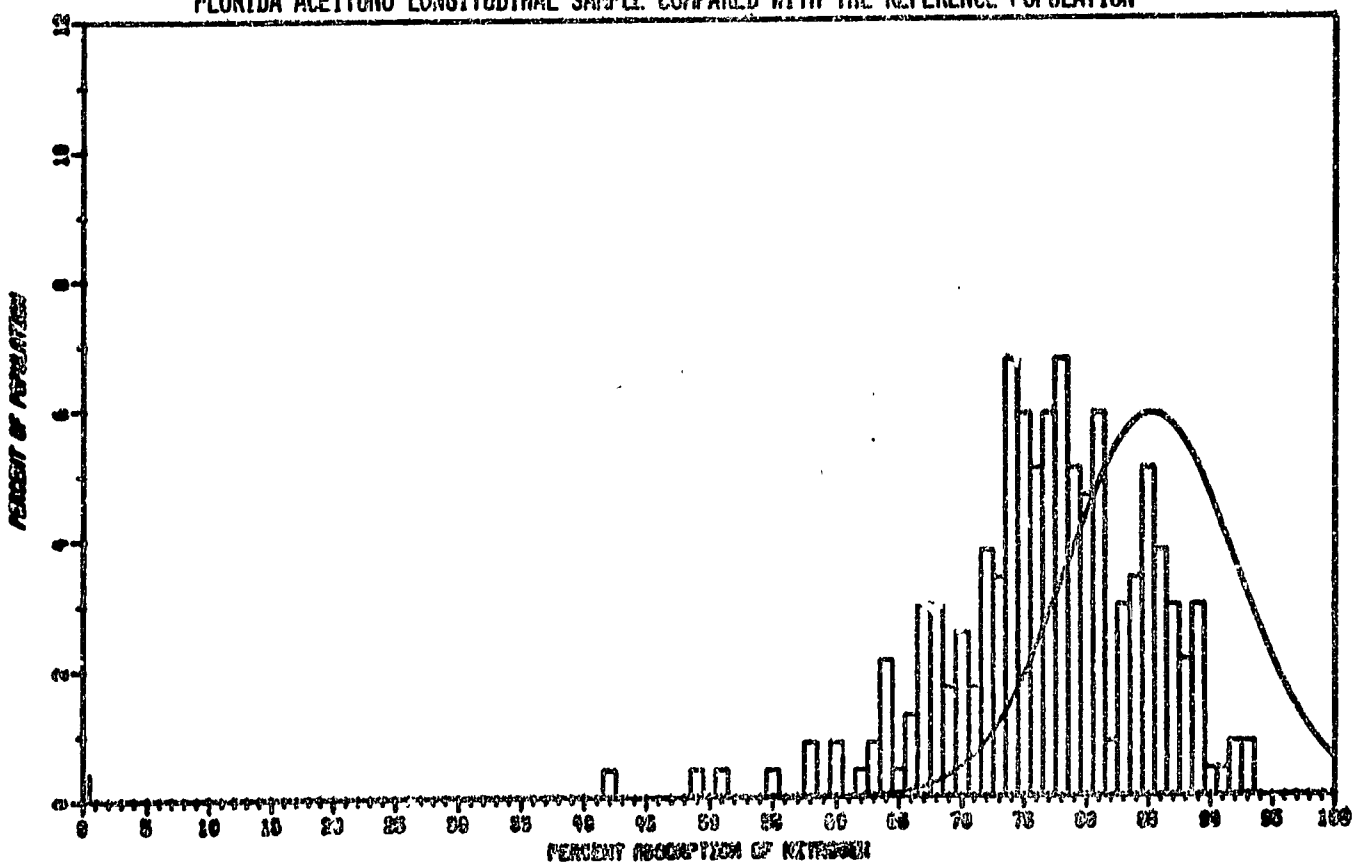
HISTOGRAM VII.11

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1973 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



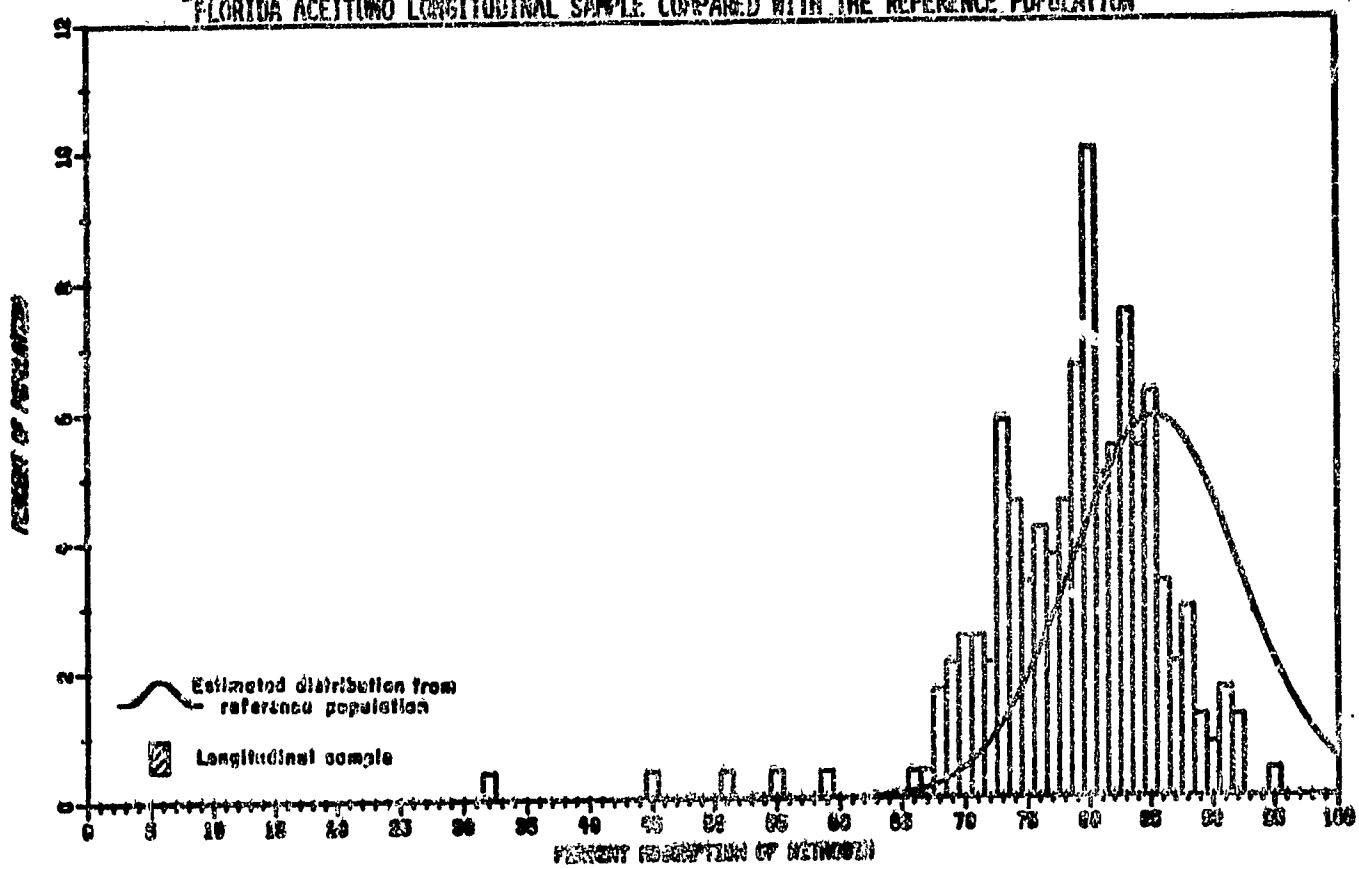
HISTOGRAM VII.12

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1974 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



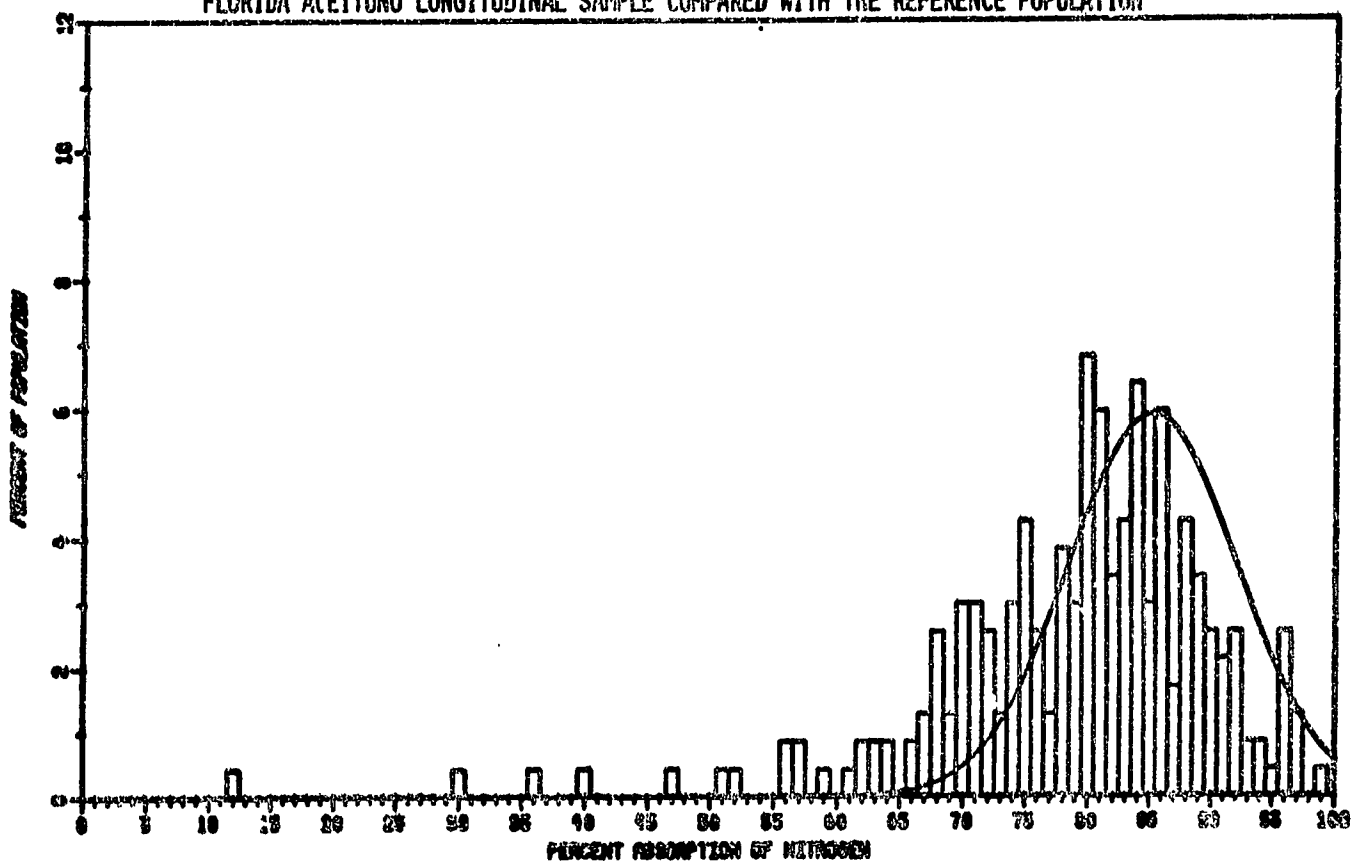
HISTOGRAM VII.13

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1975 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



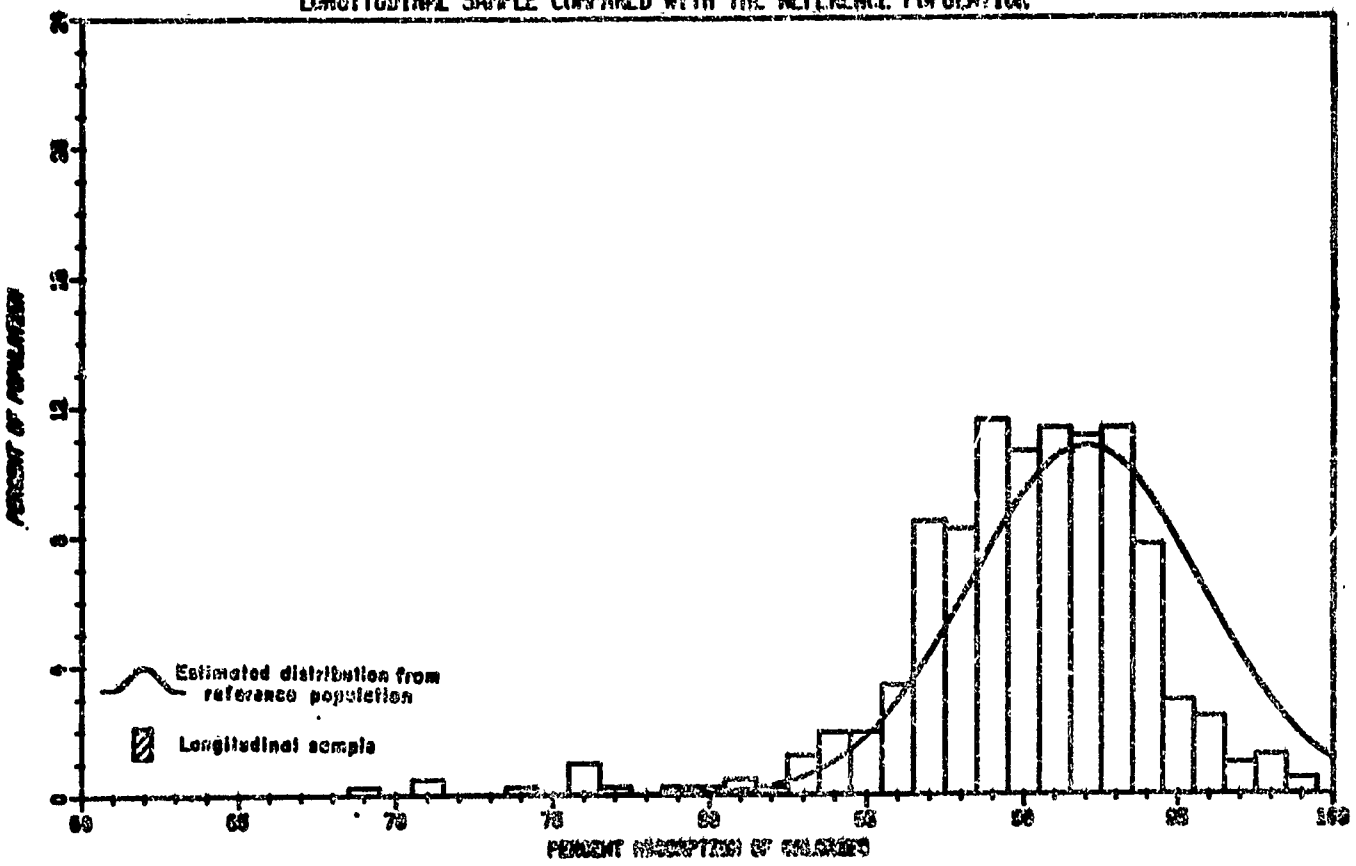
HISTOGRAM VII.14

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1976 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



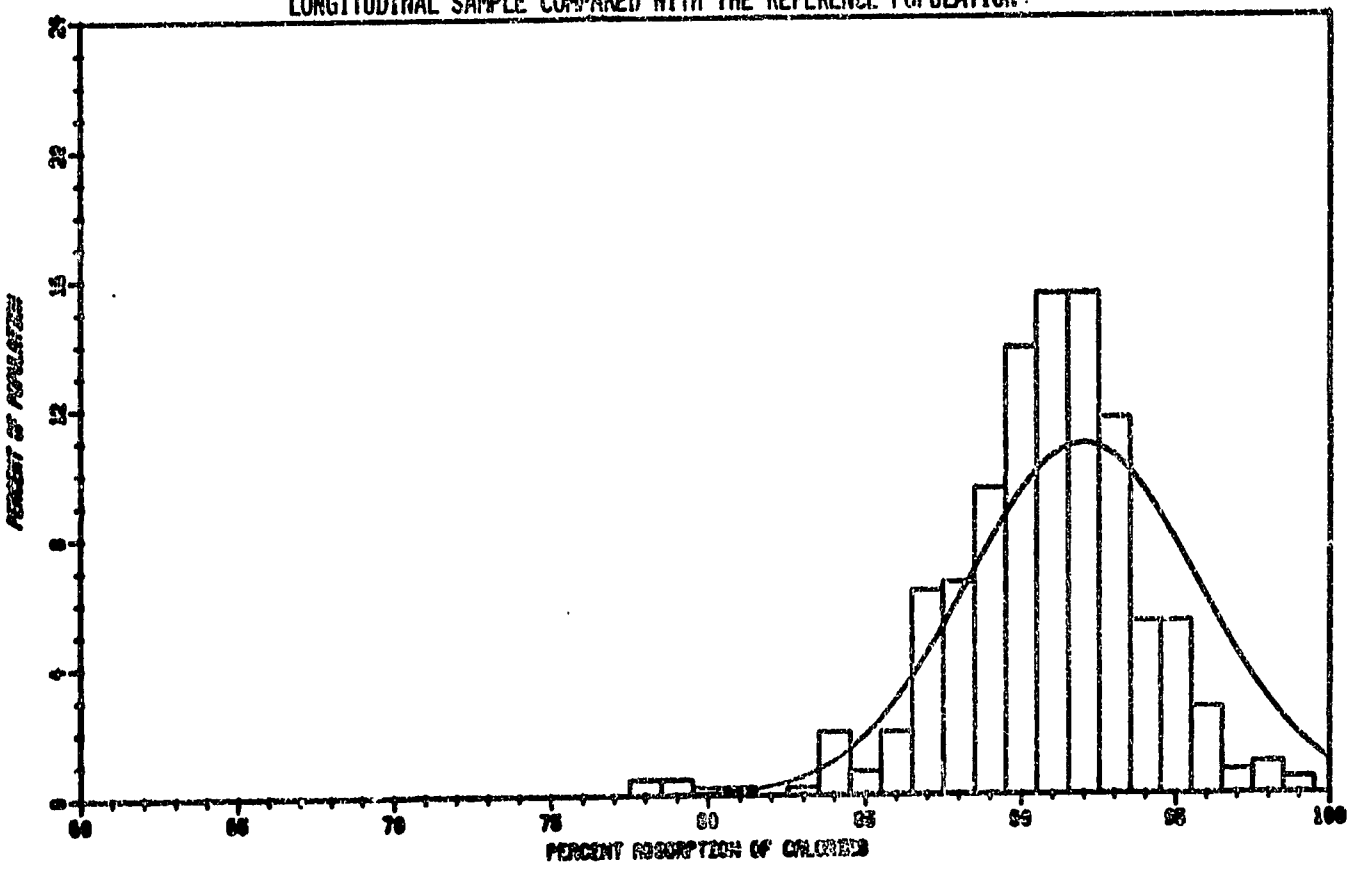
HISTOGRAM VII.15

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1973-76 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



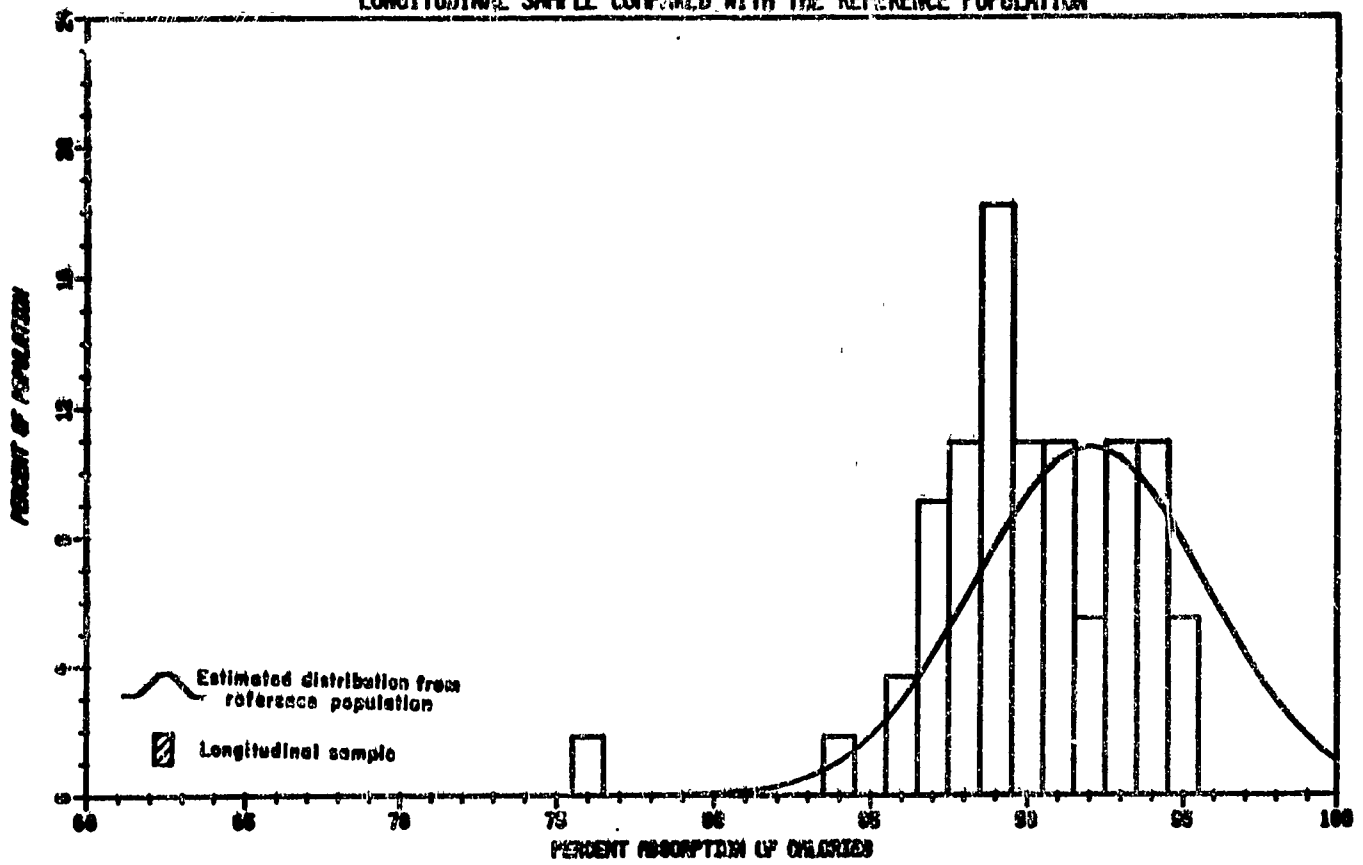
HISTOGRAM VII.16

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1973-76 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



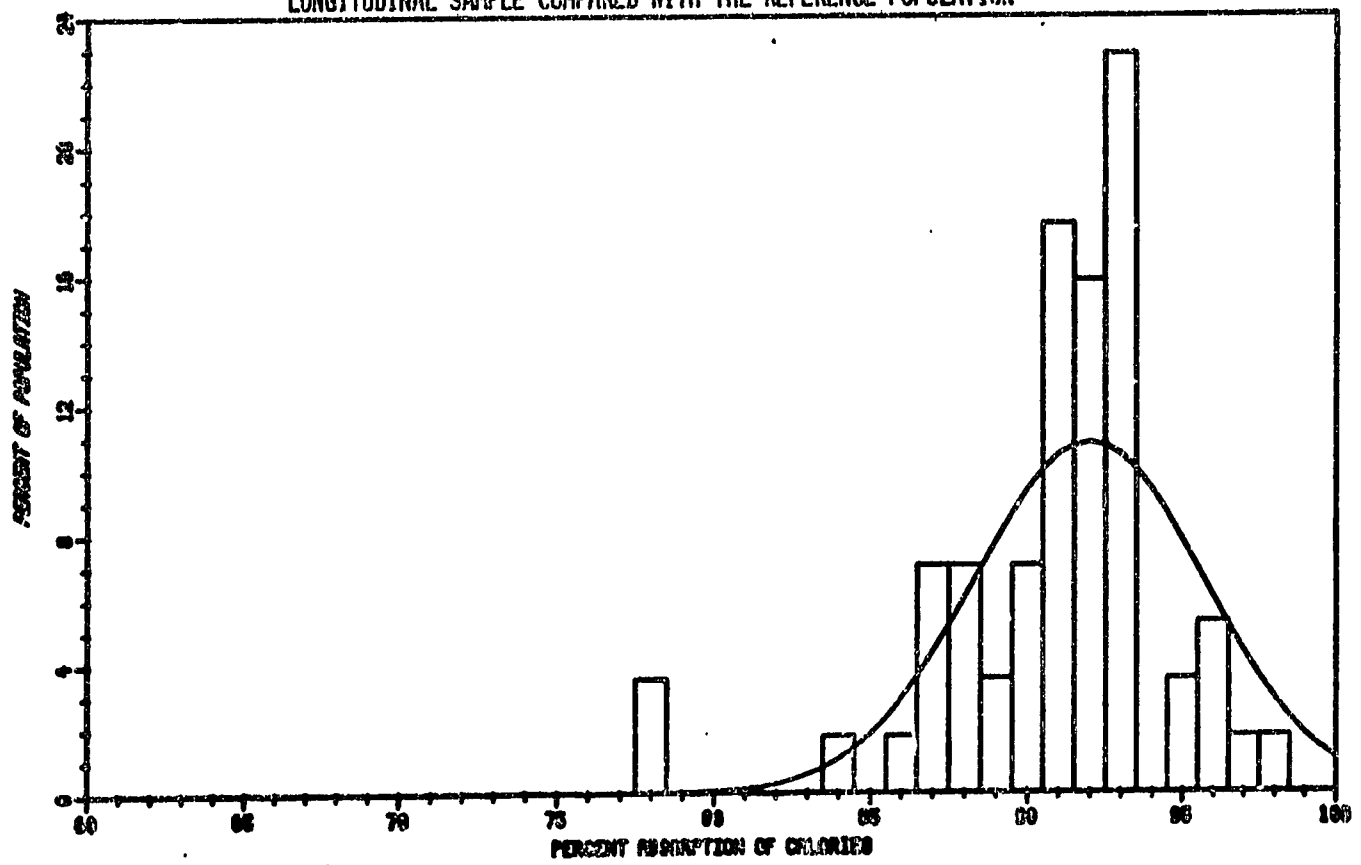
HISTOGRAM VII.17

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1973 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION

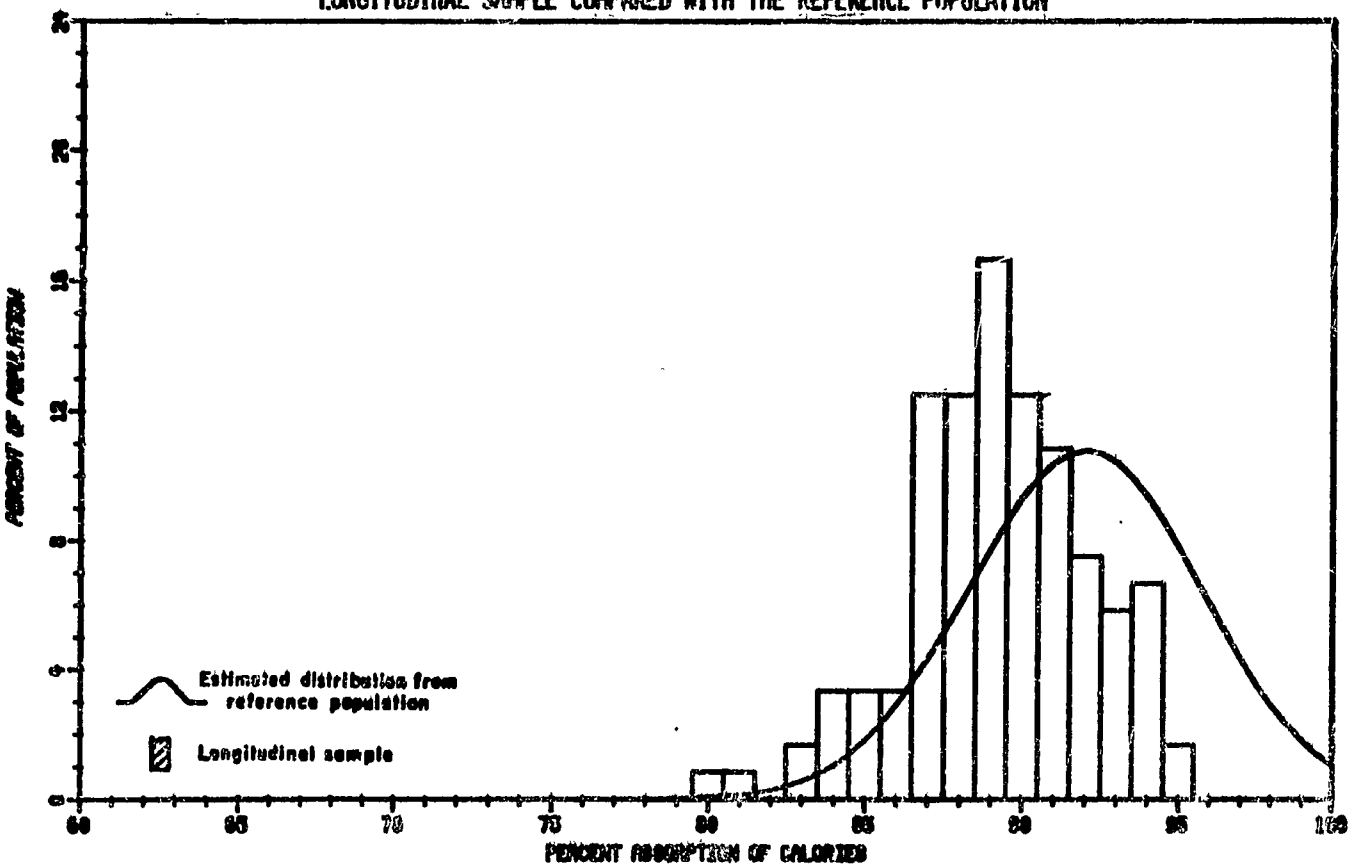


HISTOGRAM VII.18

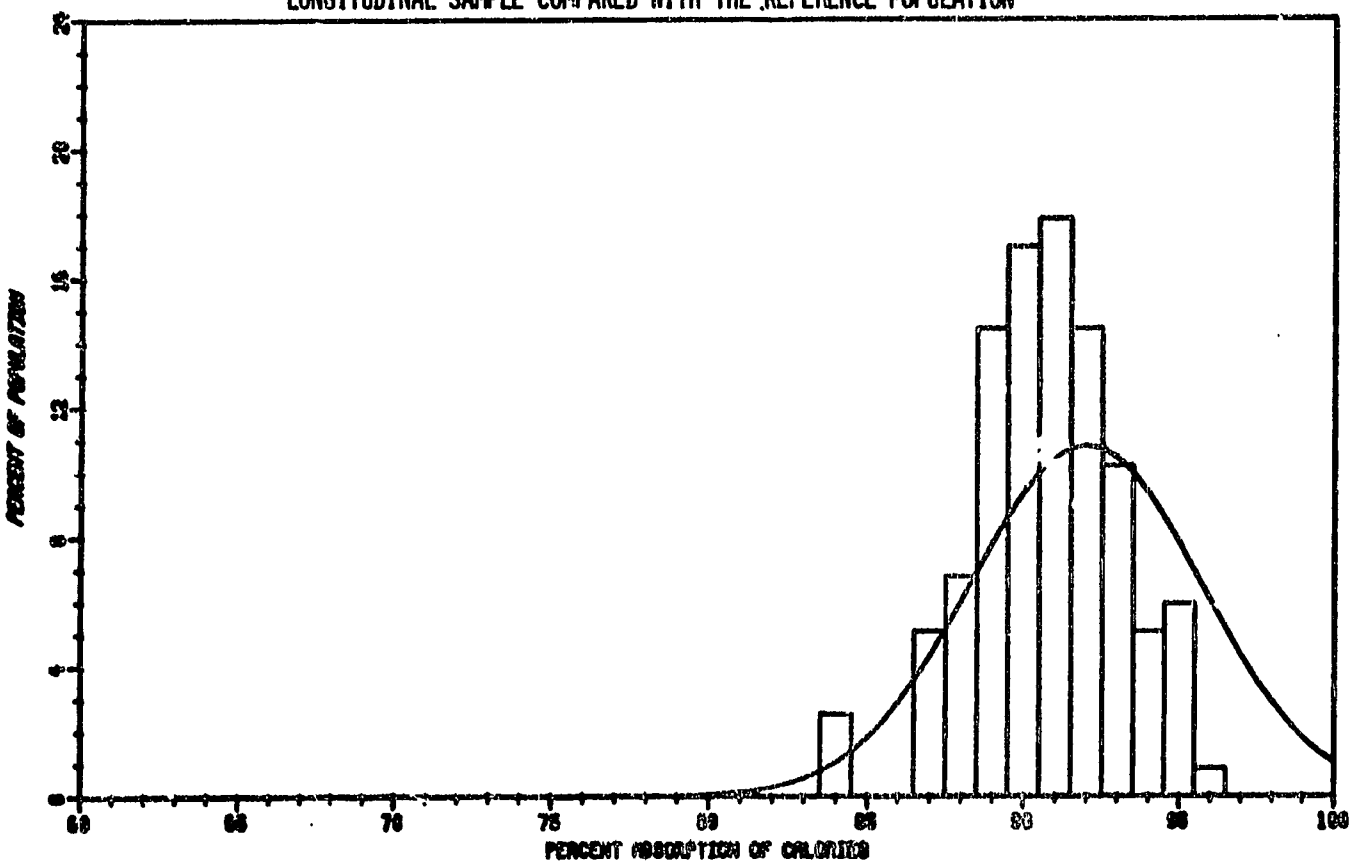
DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1973 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



HISTOGRAM VII.19
DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1974 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION

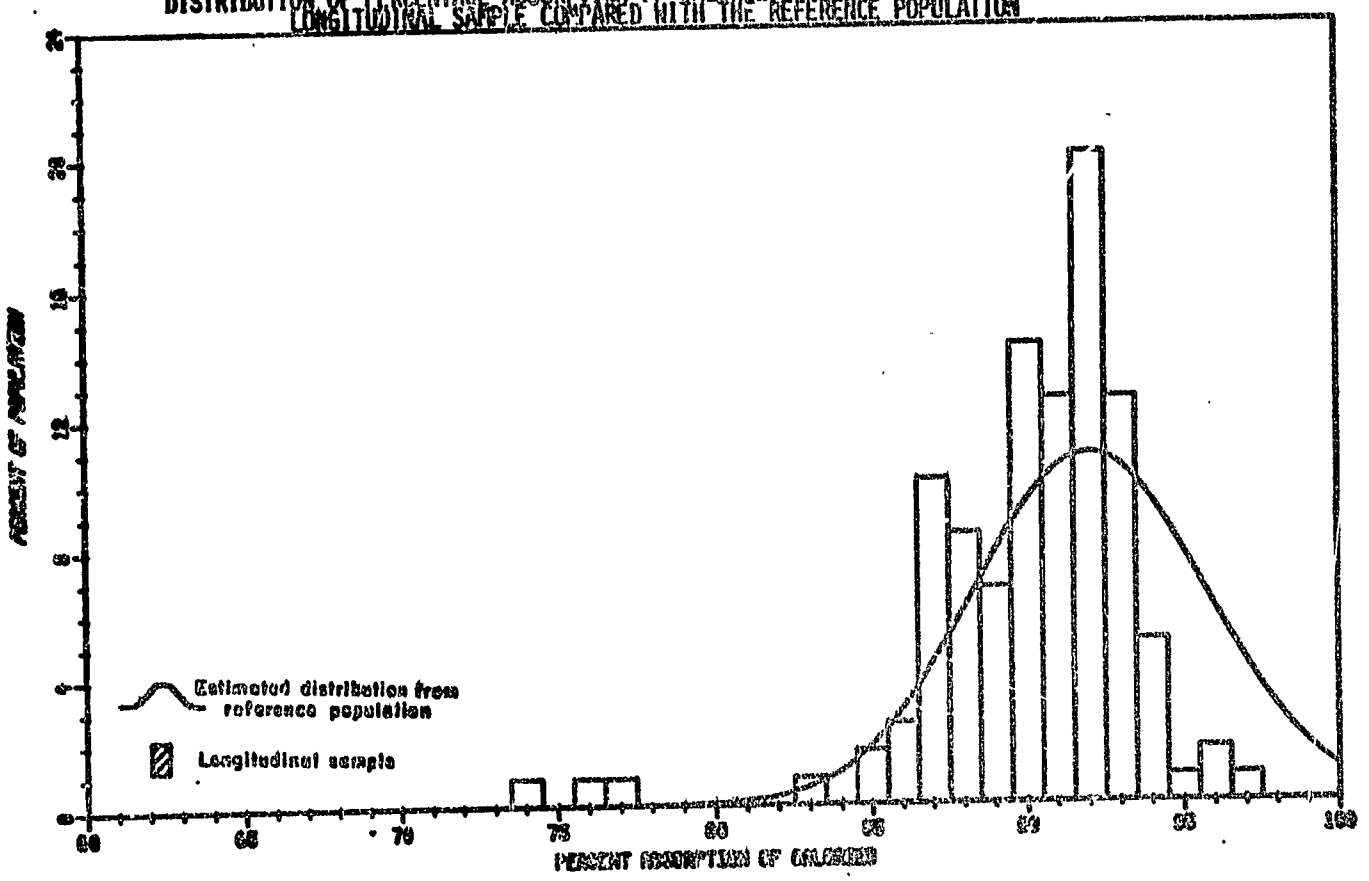


HISTOGRAM VII.20
DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1974 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



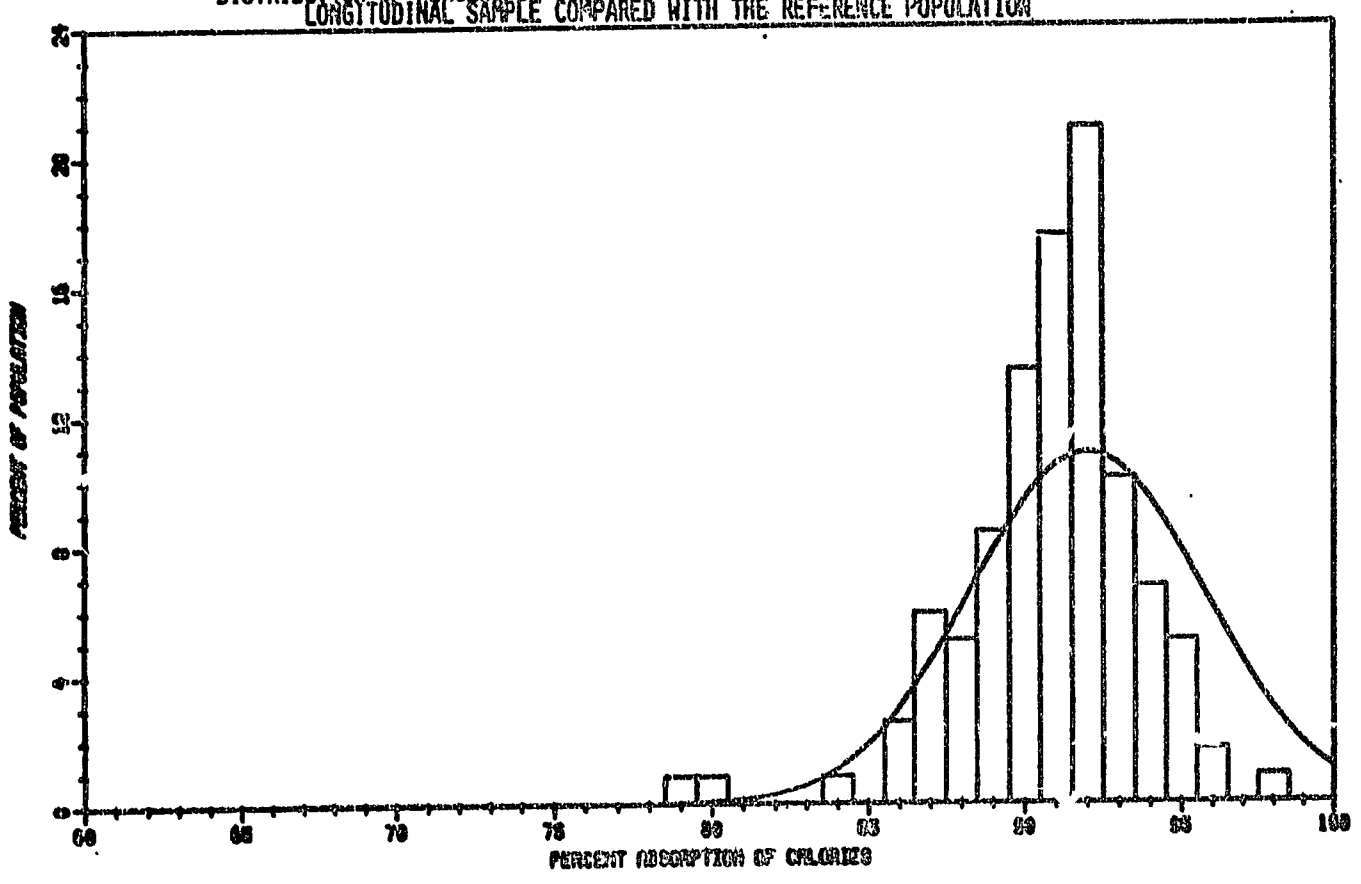
HISTOGRAM VII.21

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1975 FLORIDA ALEITURSO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



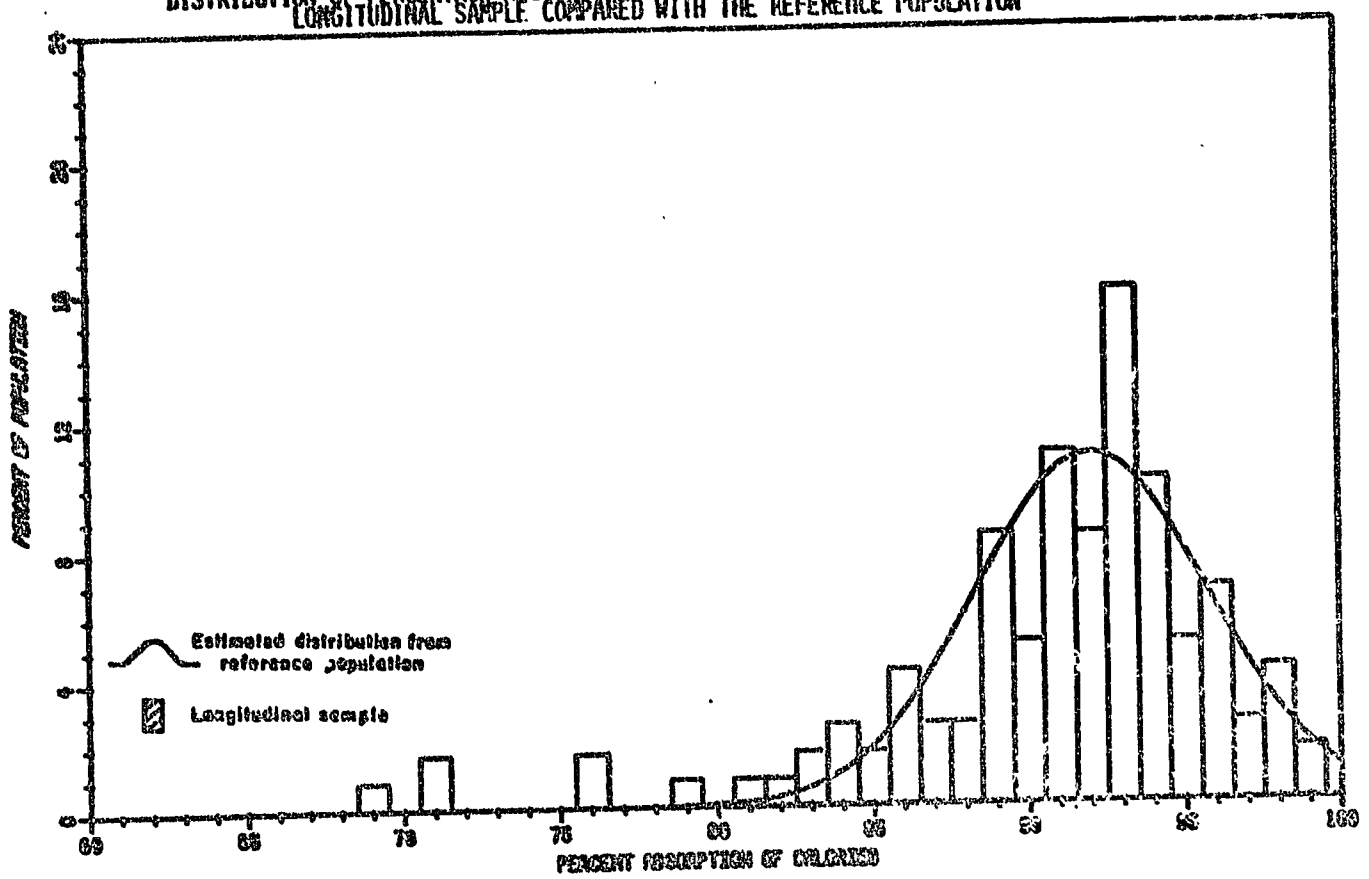
HISTOGRAM VII.22

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1975 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



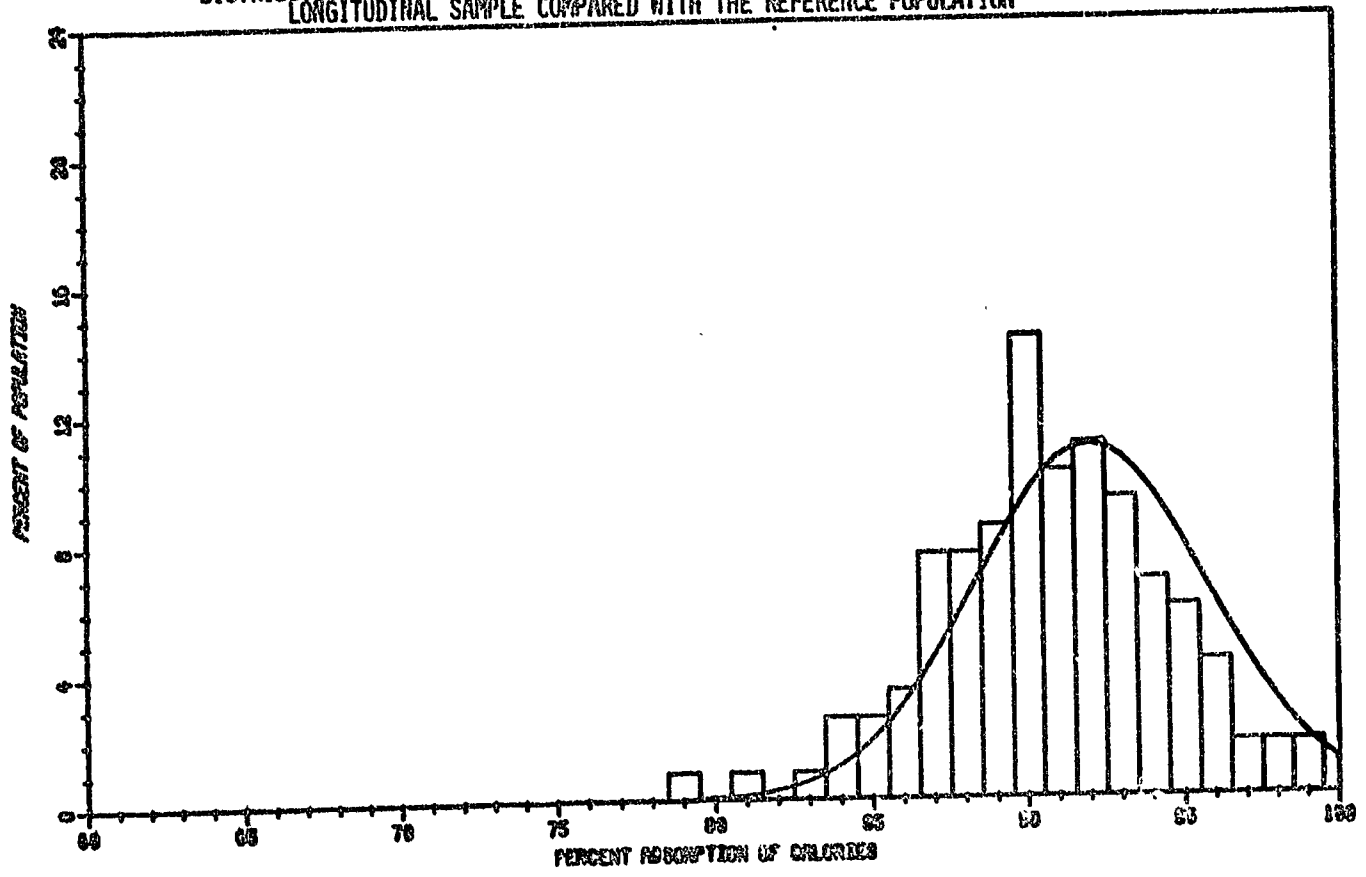
HISTOGRAM VII.23

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1976 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



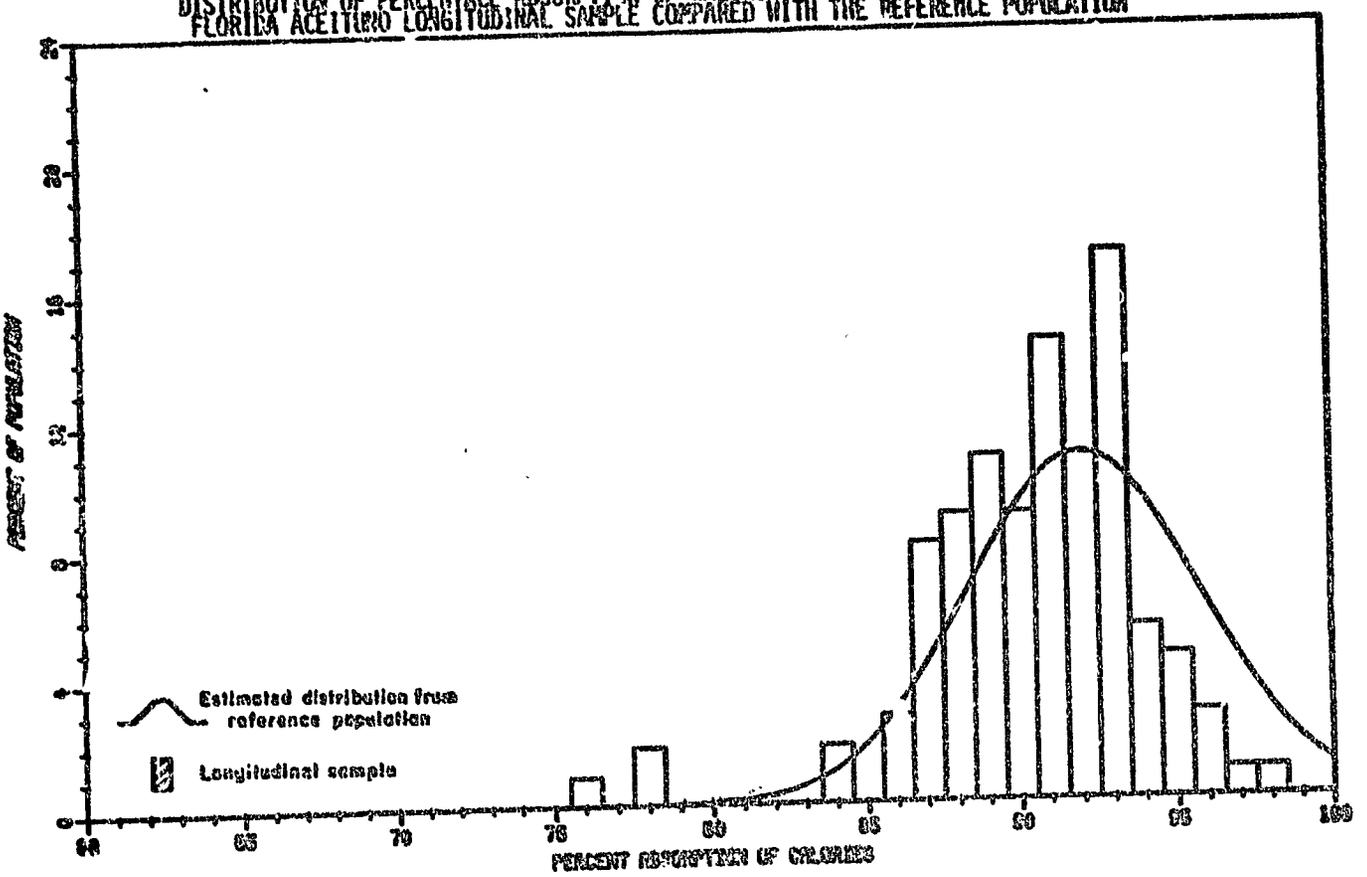
HISTOGRAM VII.24

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1976 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



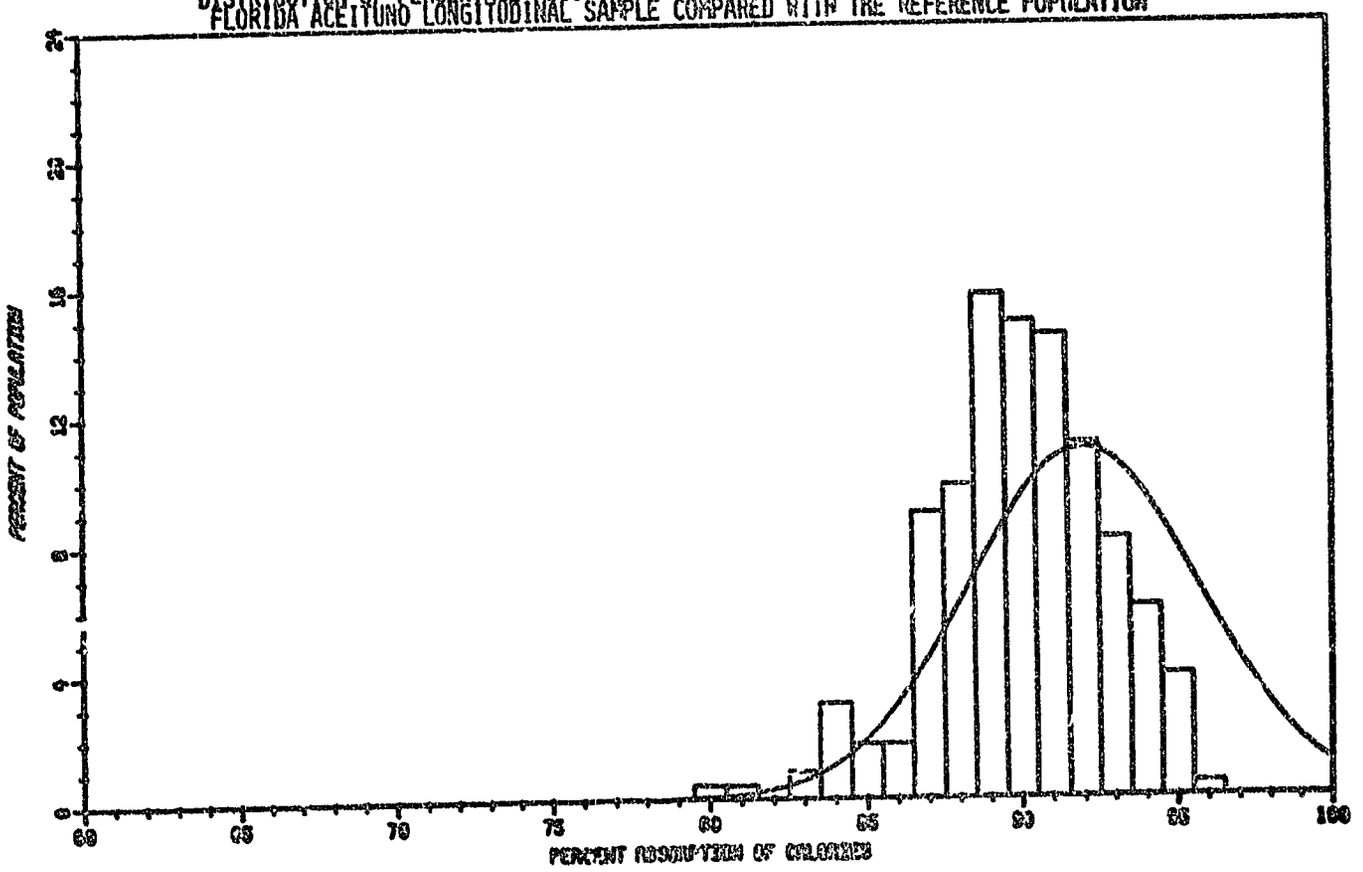
HISTOGRAM VII.25

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1973 GUAMAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



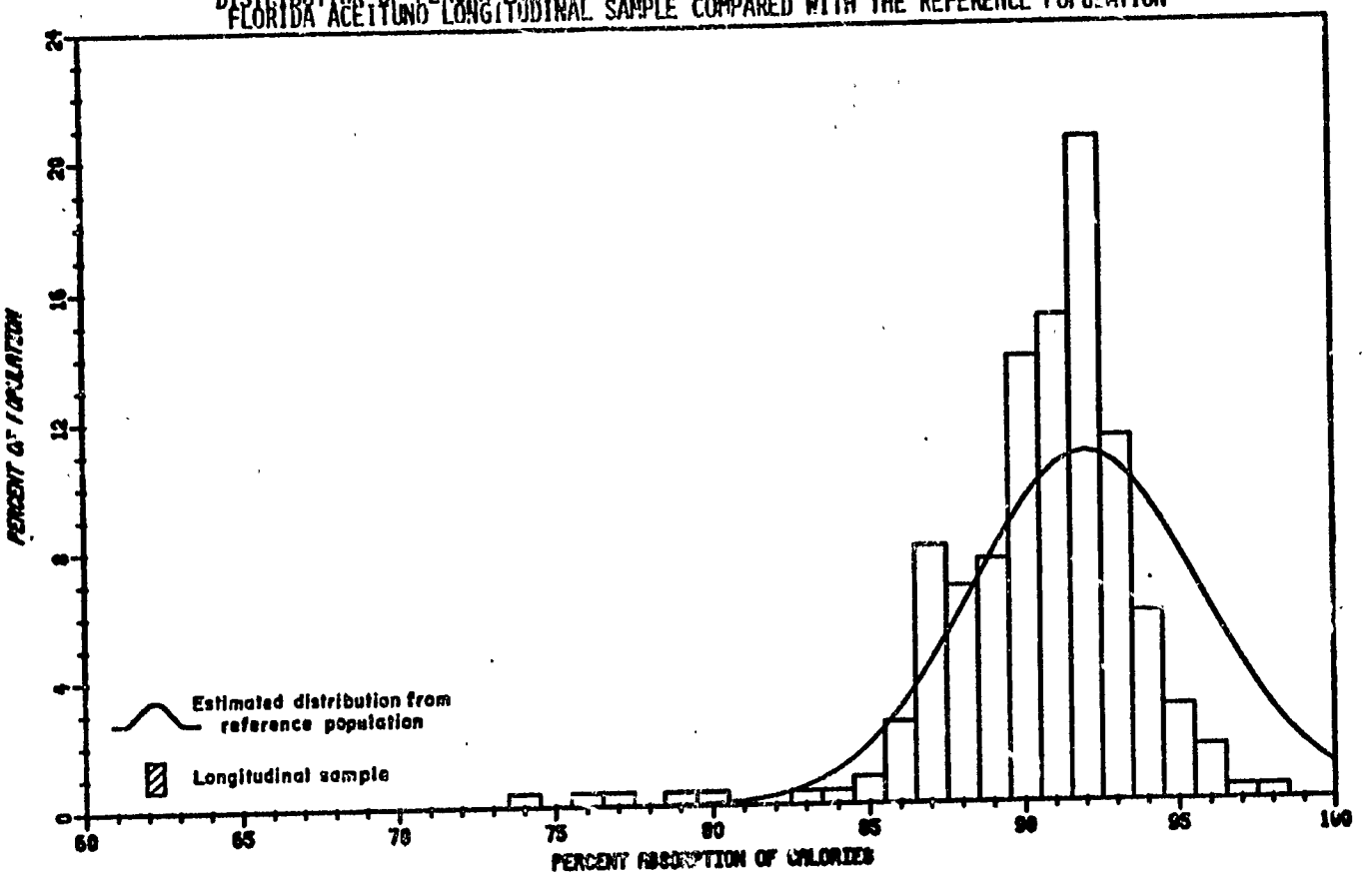
HISTOGRAM VII.26

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1974 GUAMAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



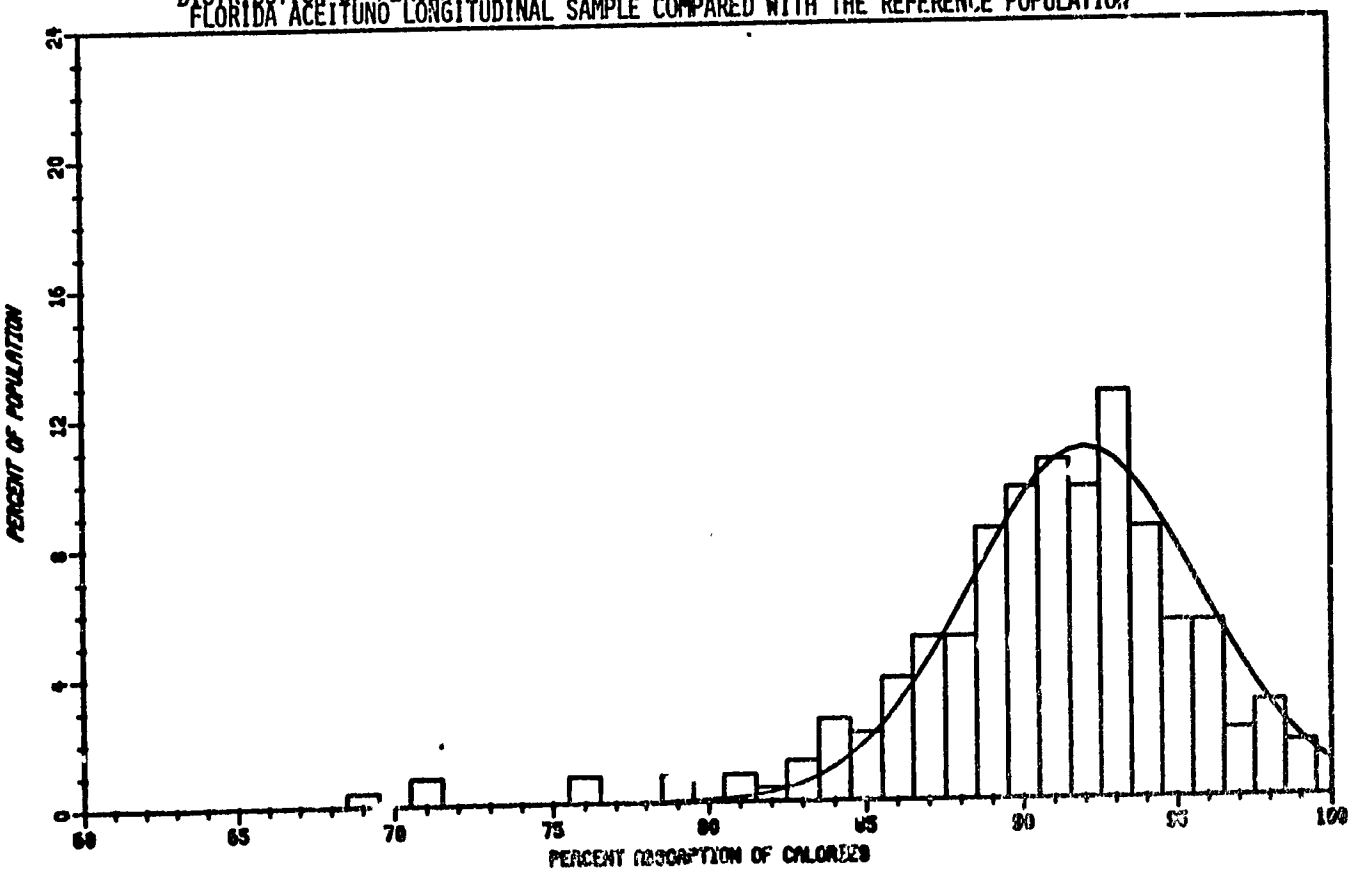
HISTOGRAM VII.27

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1975 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



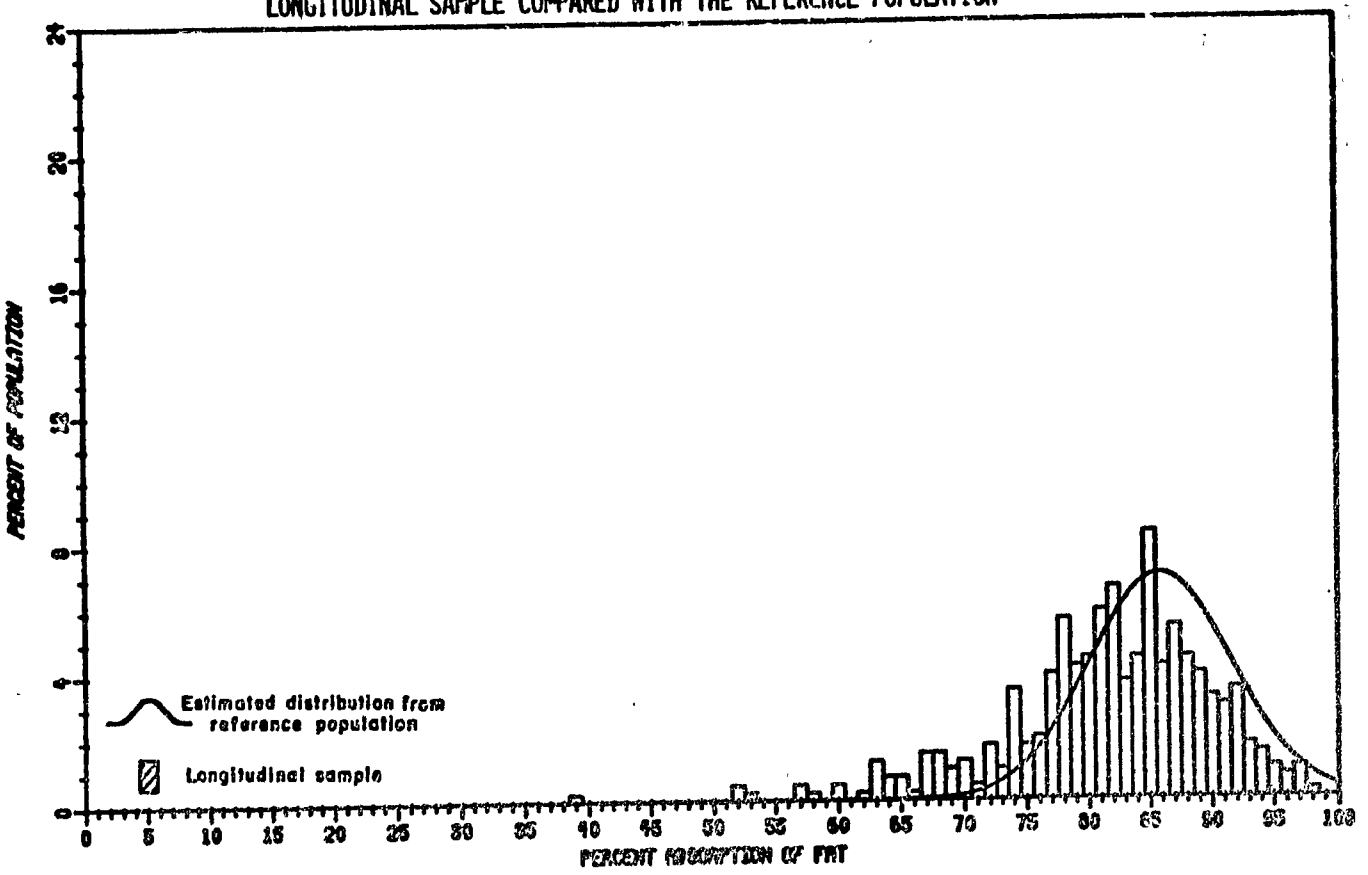
HISTOGRAM VII.28

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1976 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



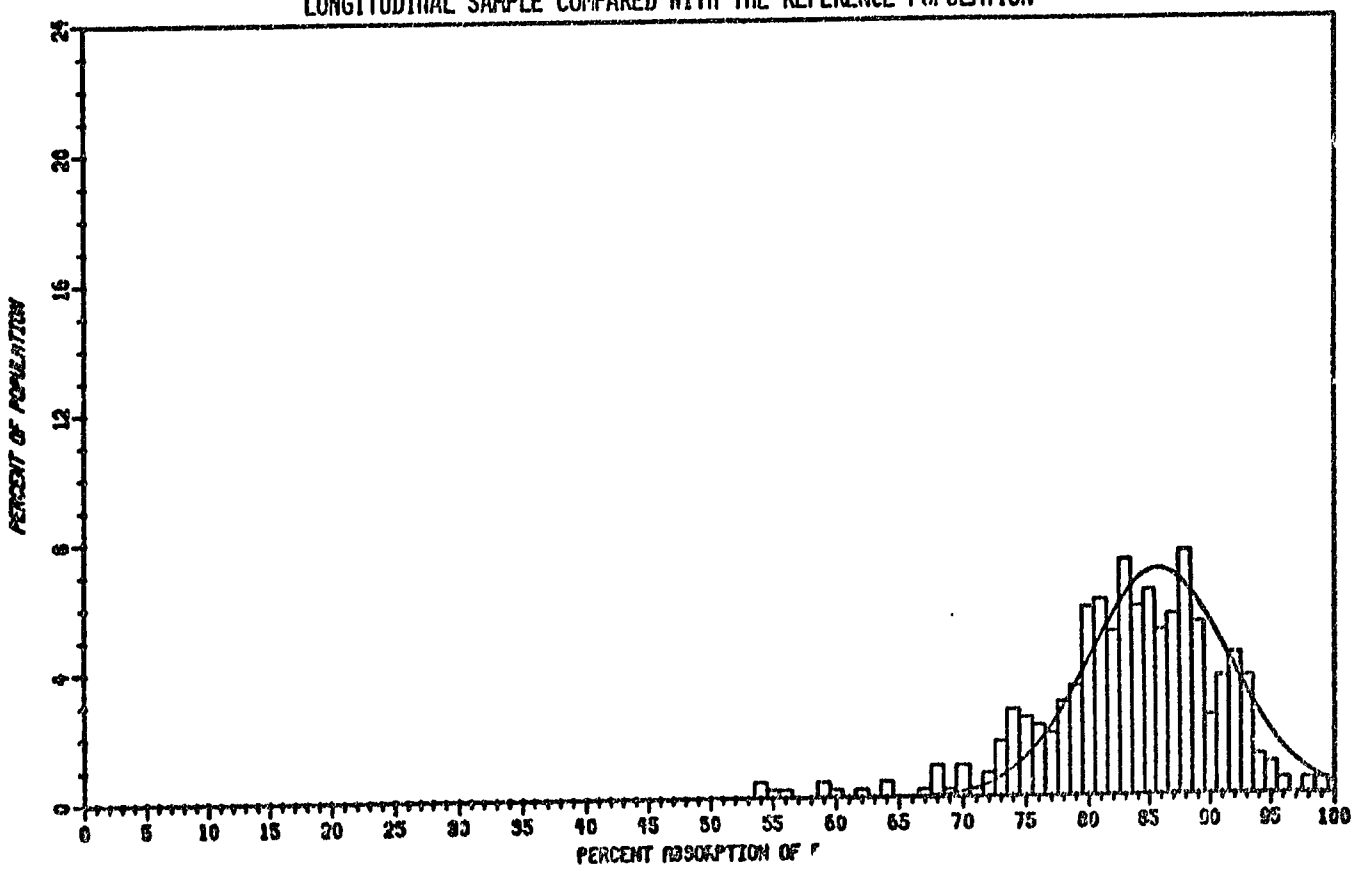
HISTOGRAM VII.29

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1973-76 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



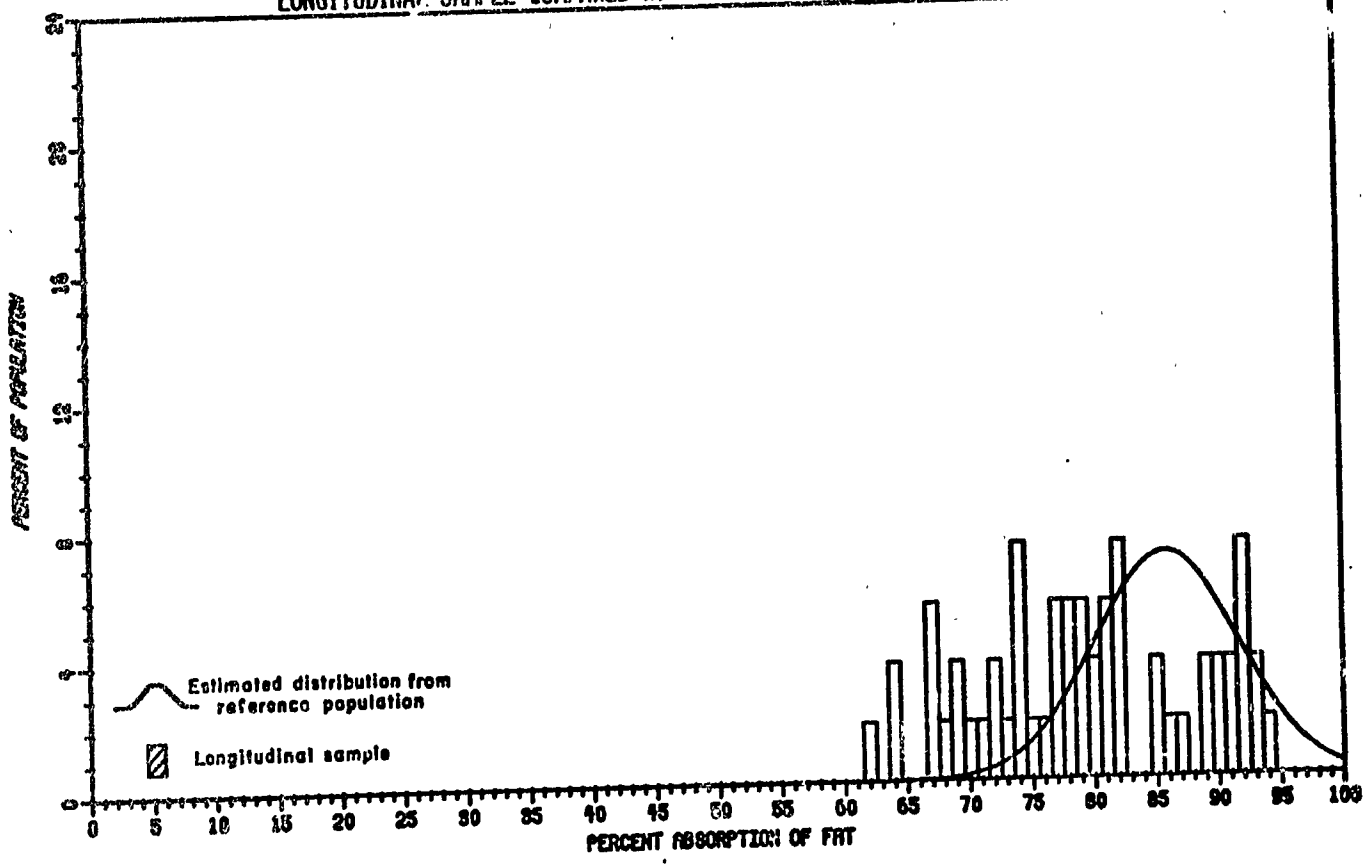
HISTOGRAM VII.30

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1973-76 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



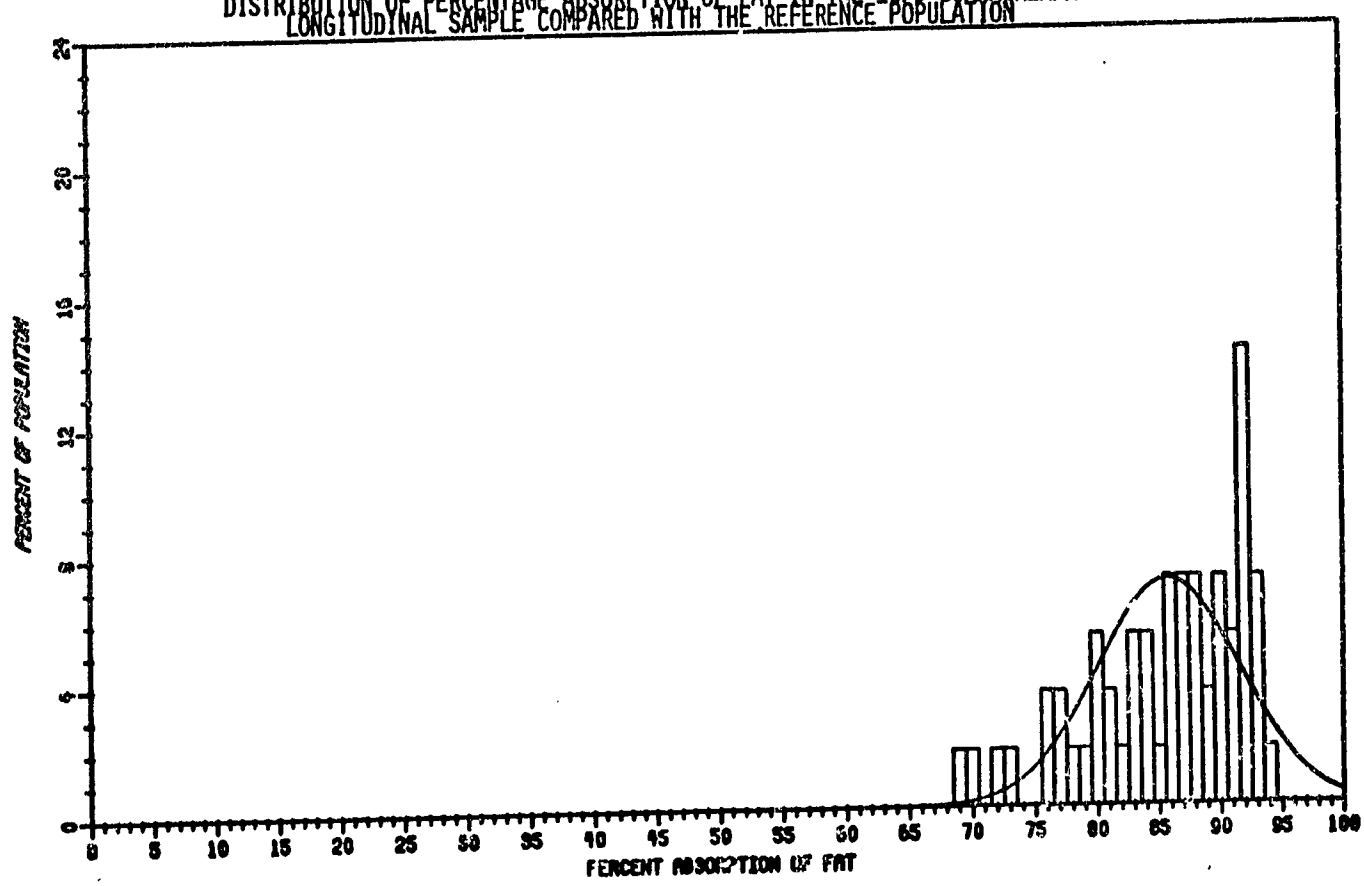
HISTOGRAM VII.31

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1973 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



HISTOGRAM VII.32

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1973 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



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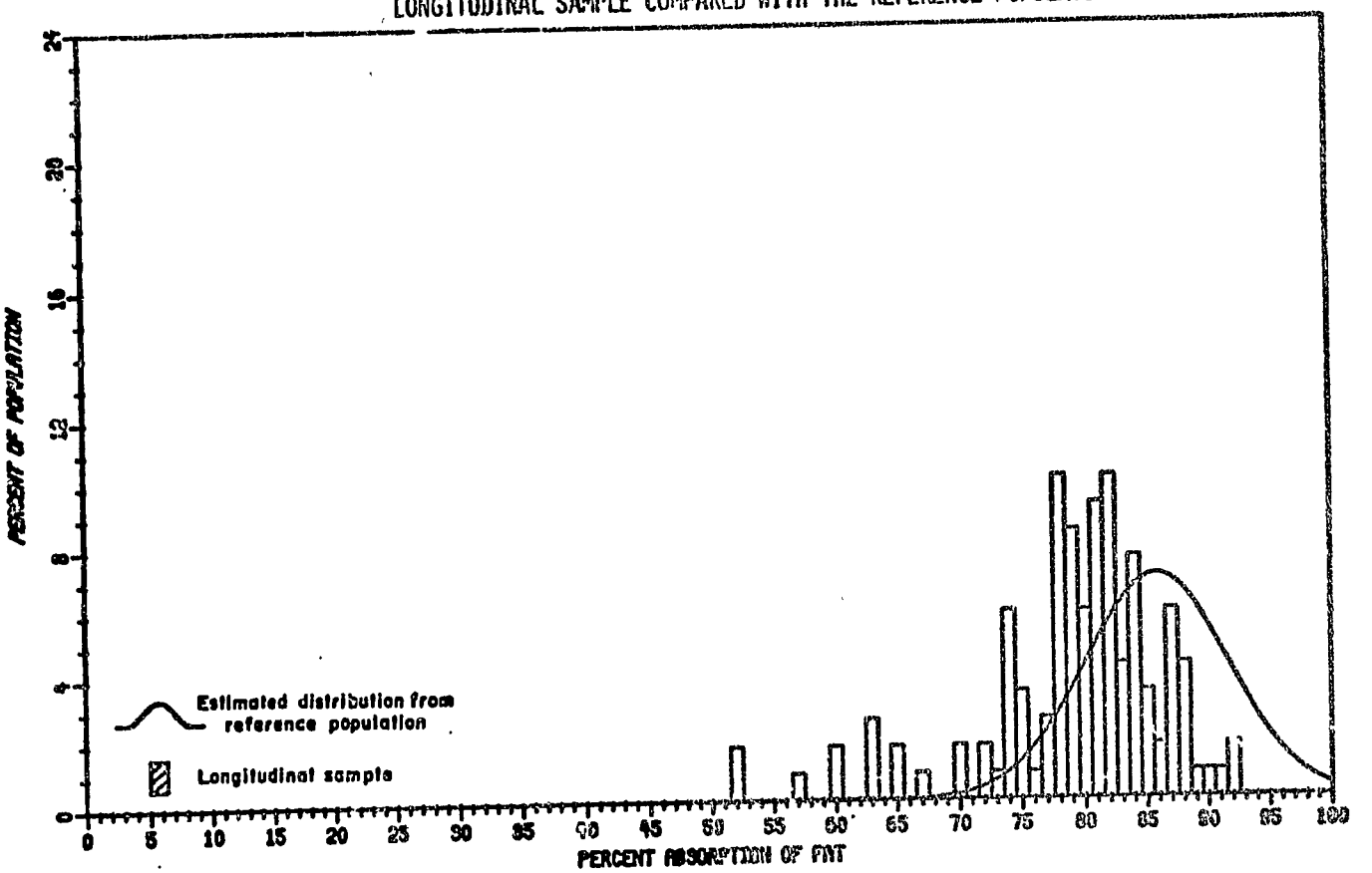
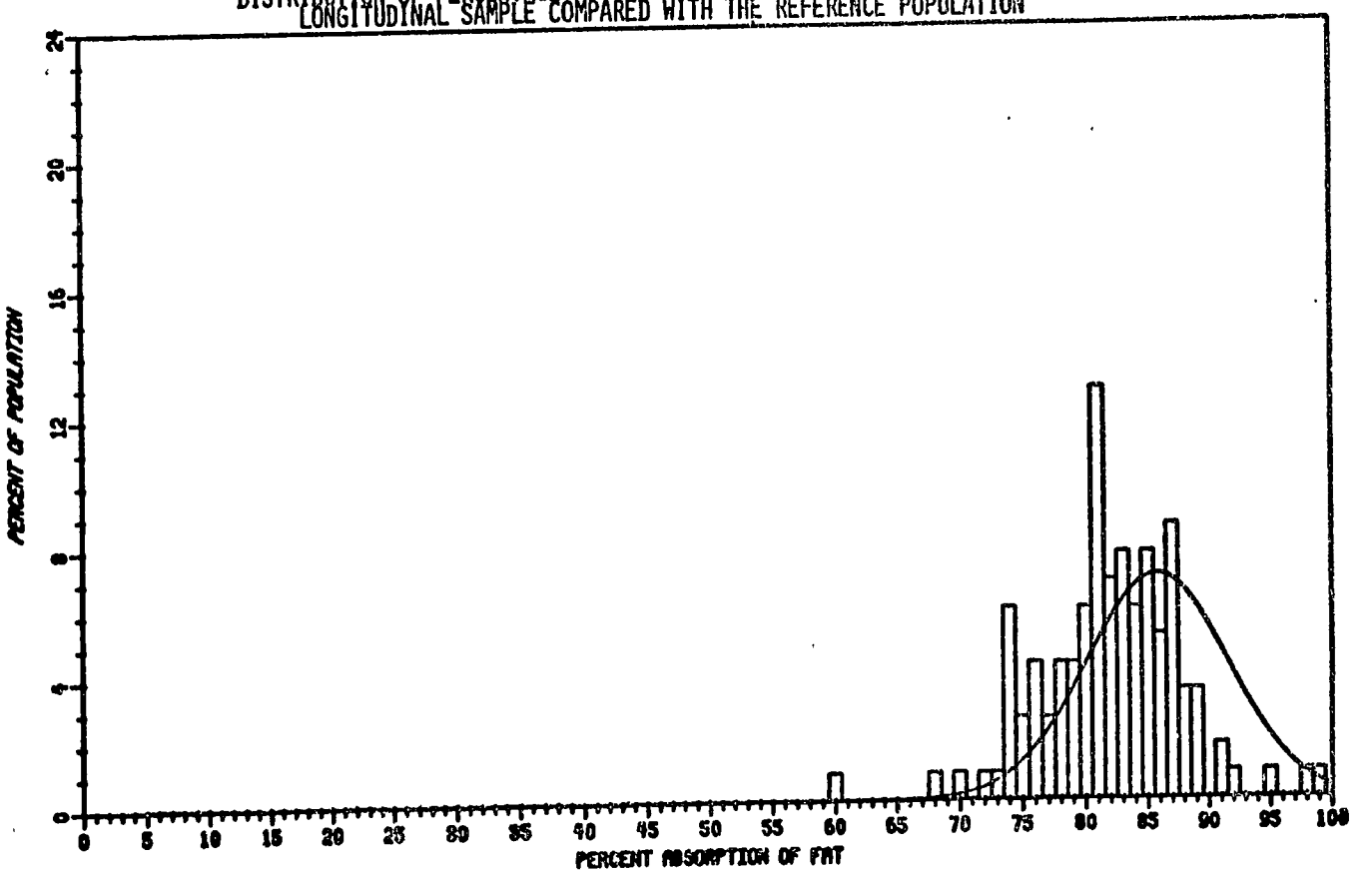
DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1974 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION

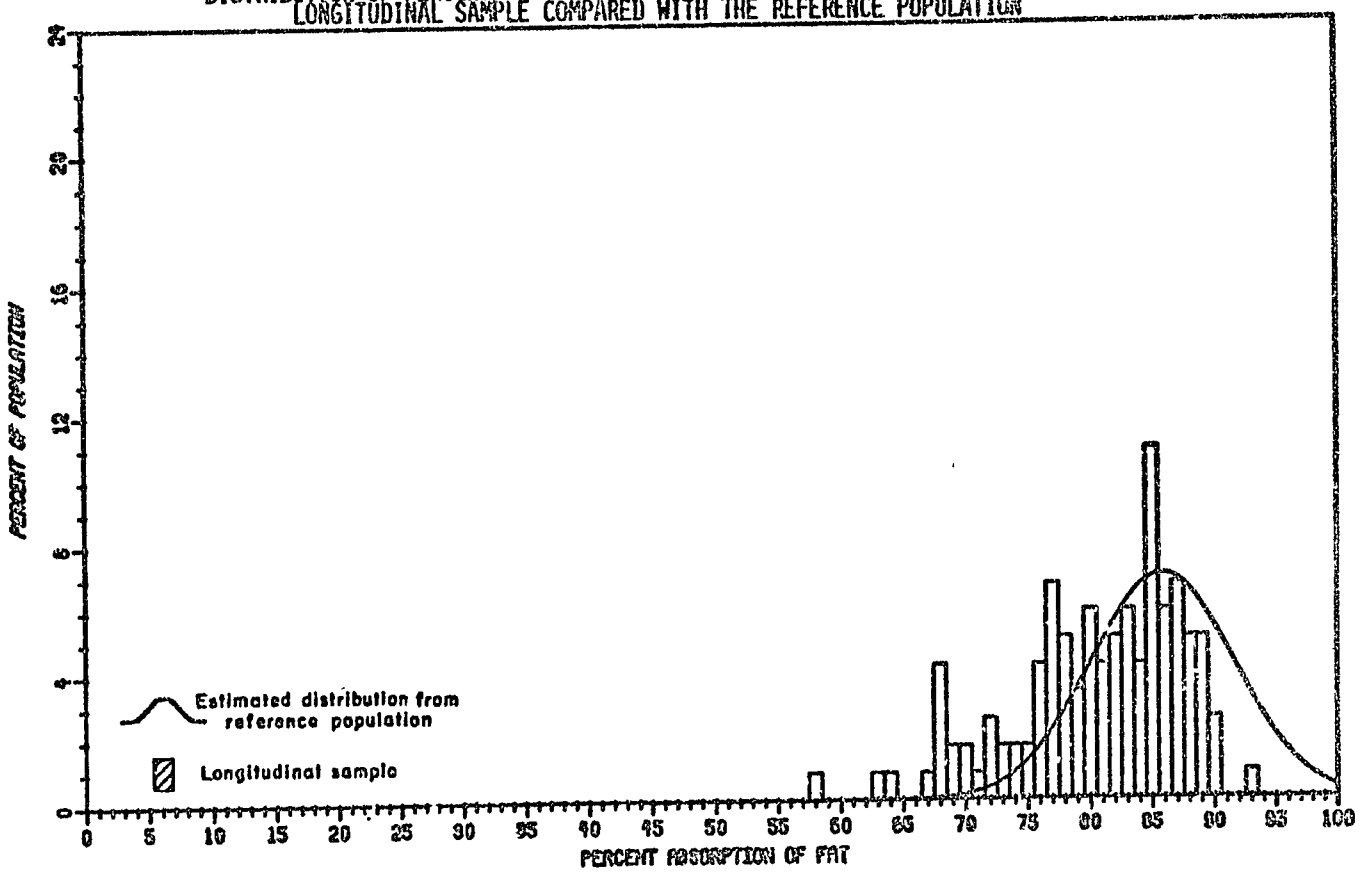


HISTOGRAM VII.34
DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1974 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



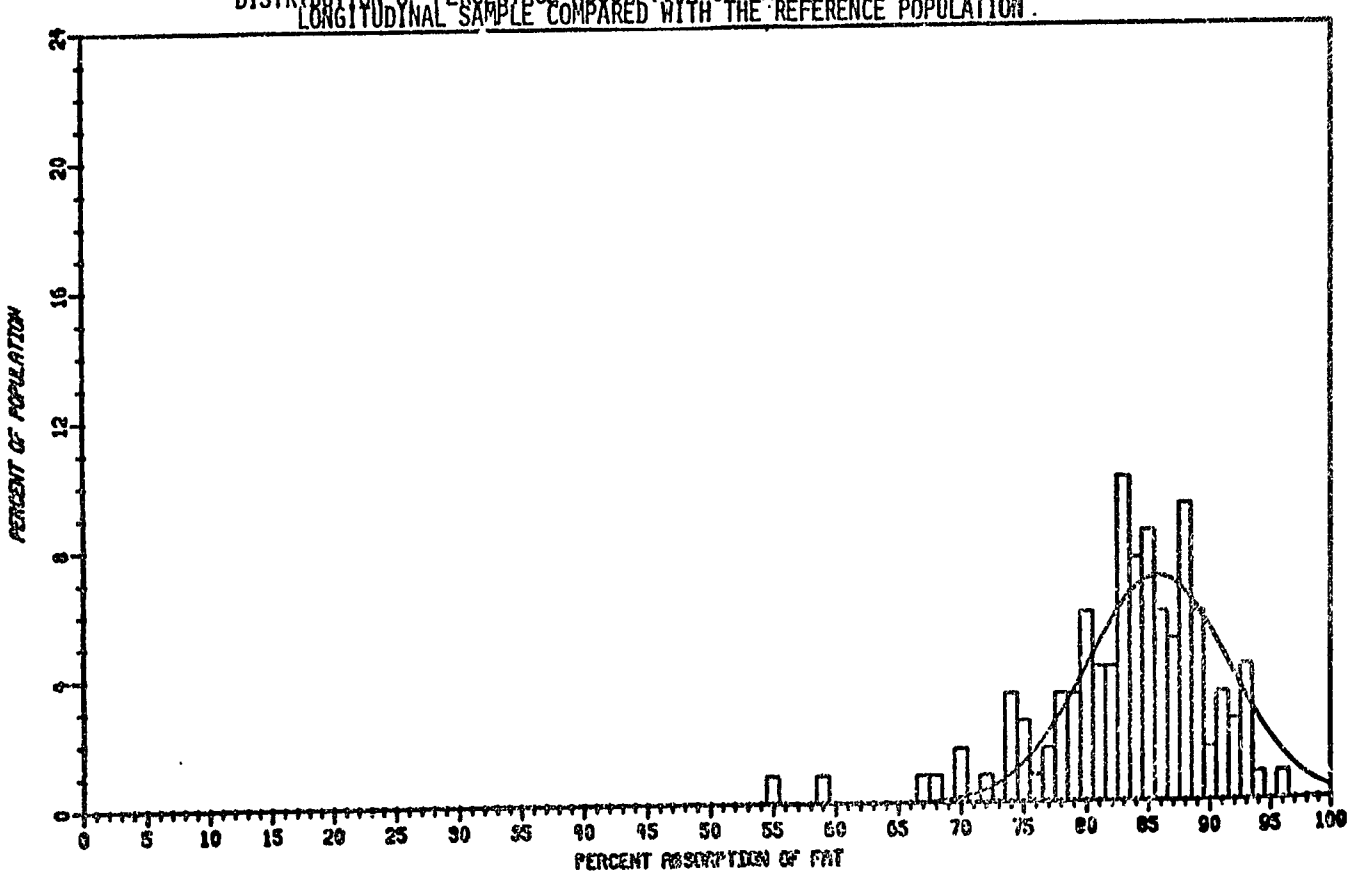
HISTOGRAM VII.35

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1975 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



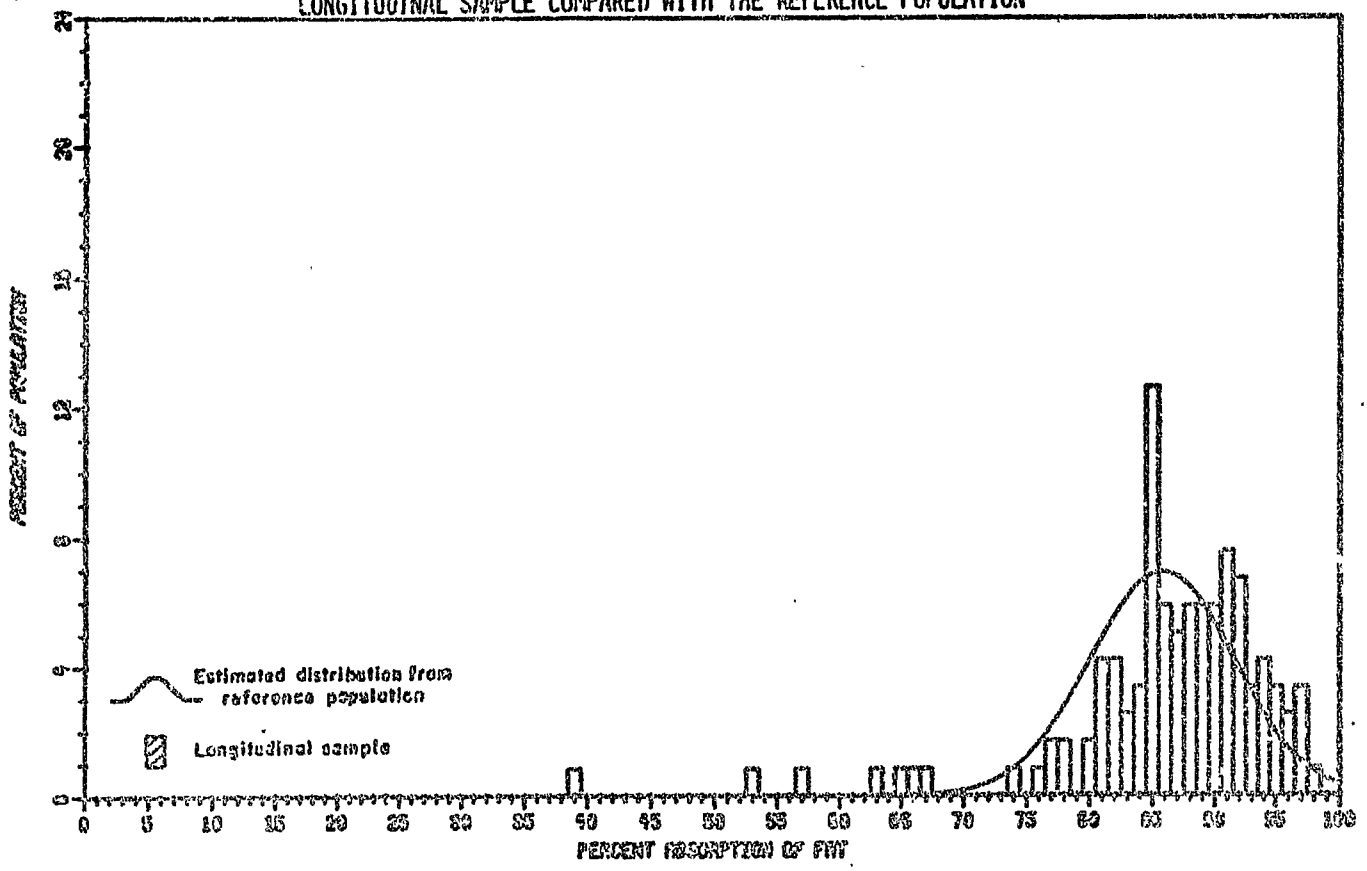
HISTOGRAM VII.36

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1975 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



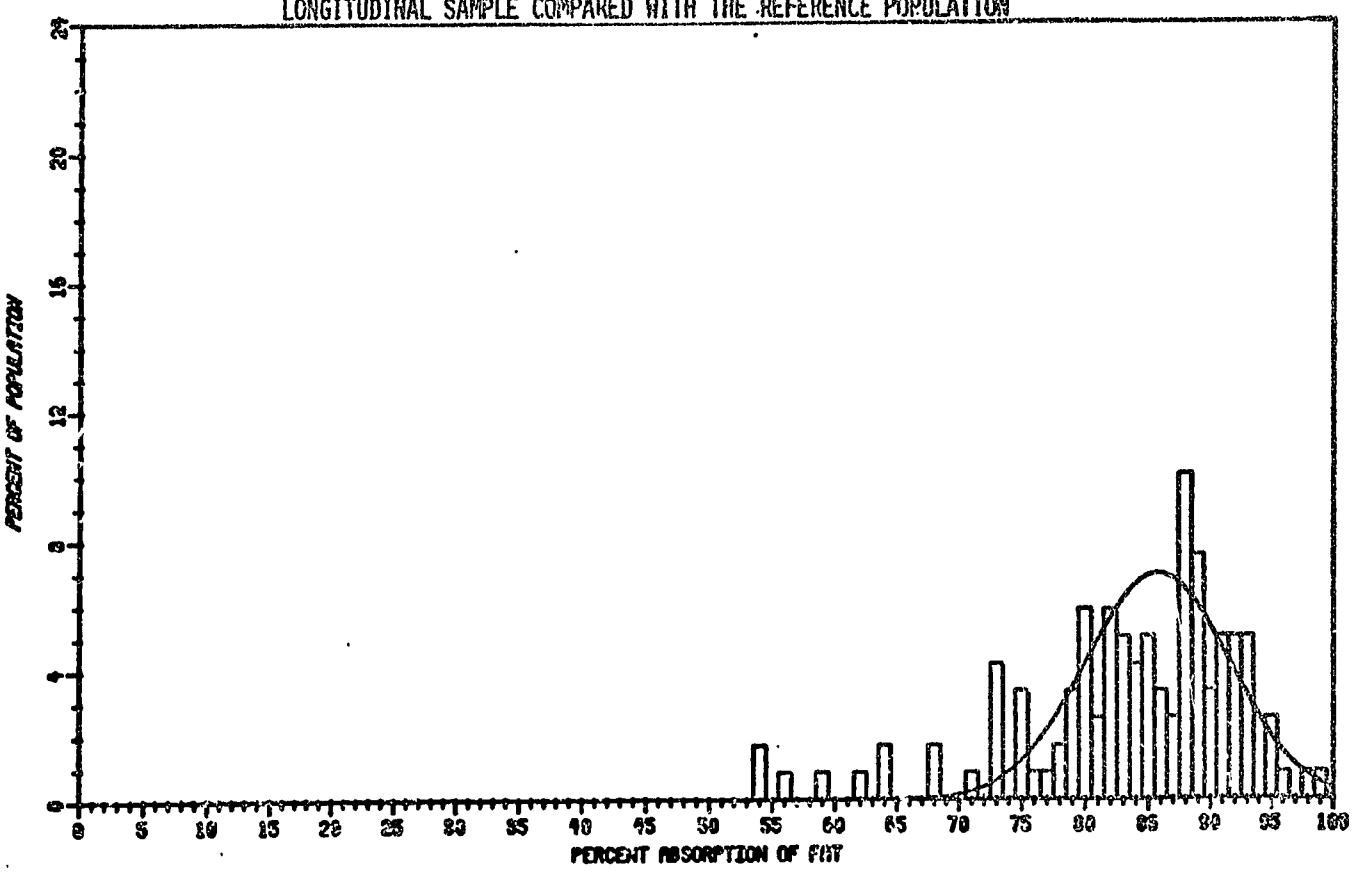
HISTOGRAM VII.37

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1976 FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



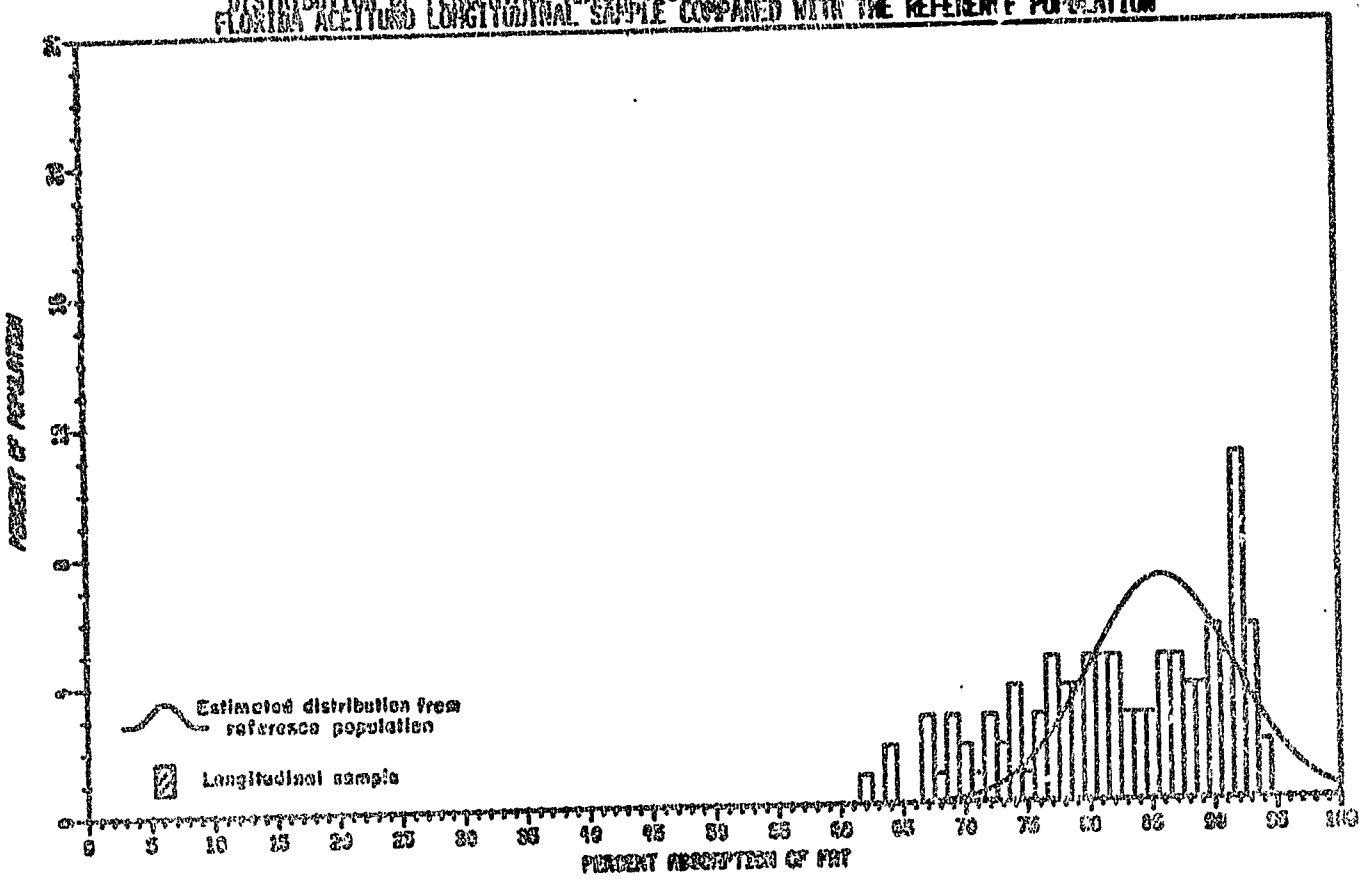
HISTOGRAM VII.38

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1976 GUANAGAZAPA LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



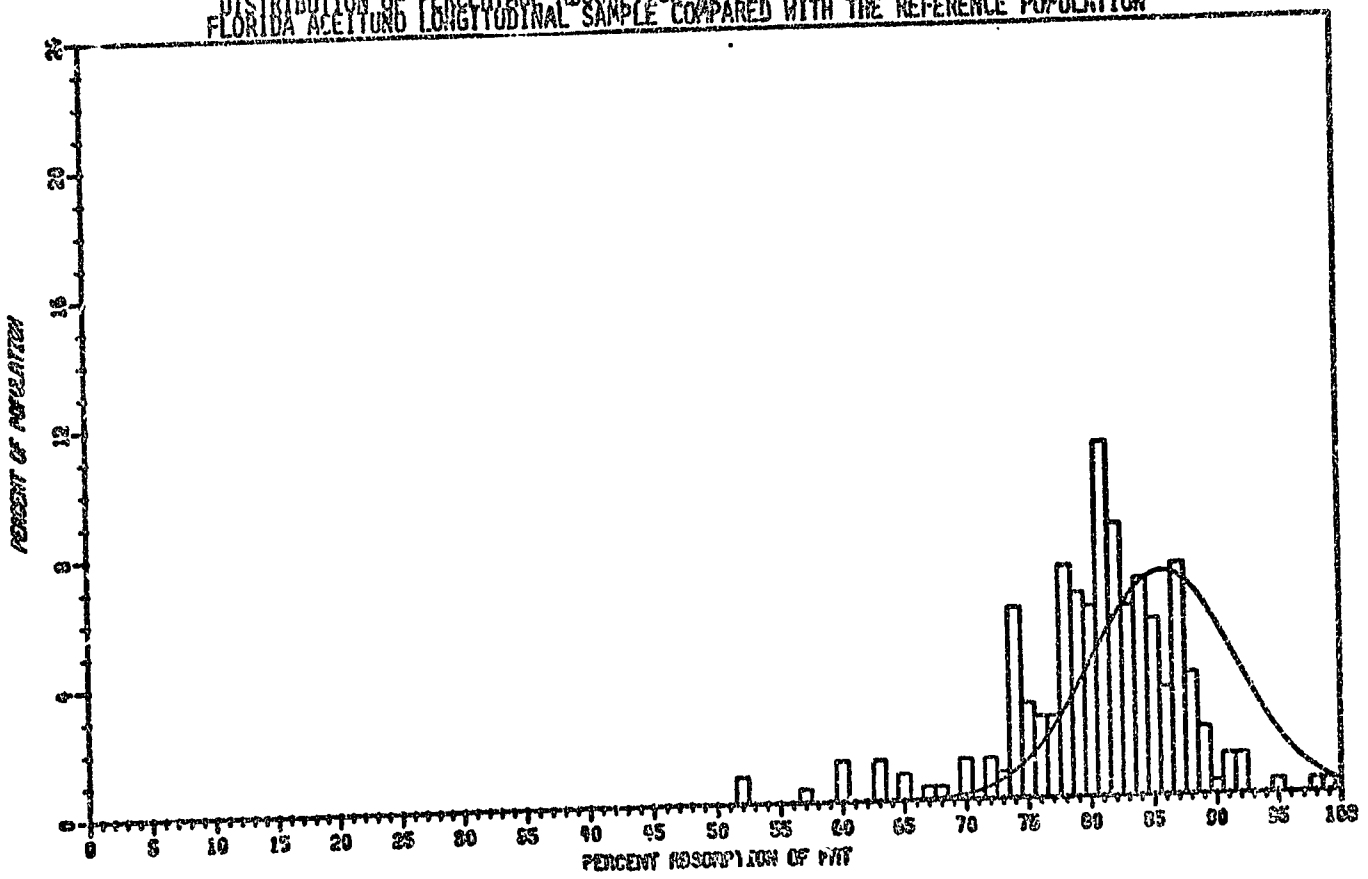
HISTOGRAM VII.39

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1973 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



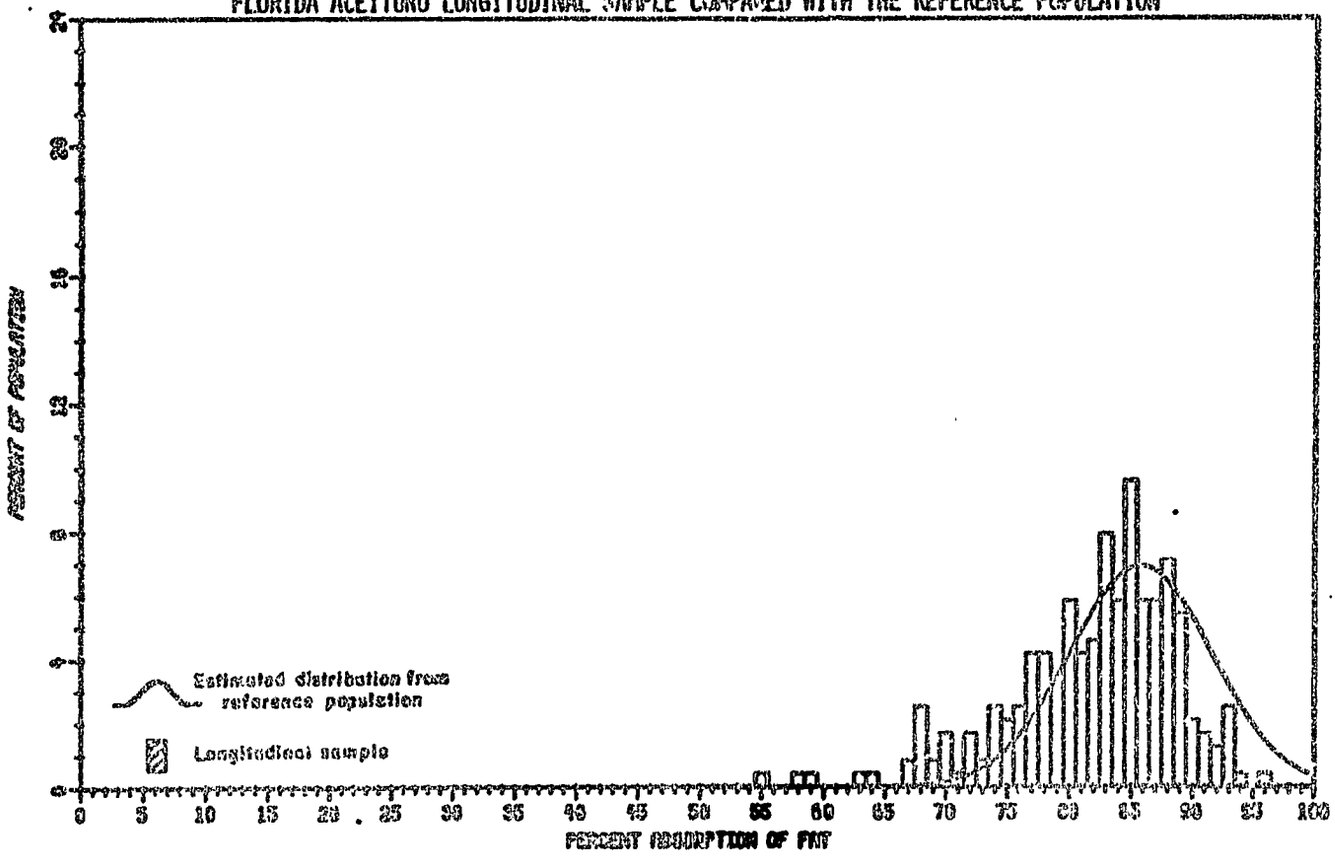
HISTOGRAM VII.40

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1974 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



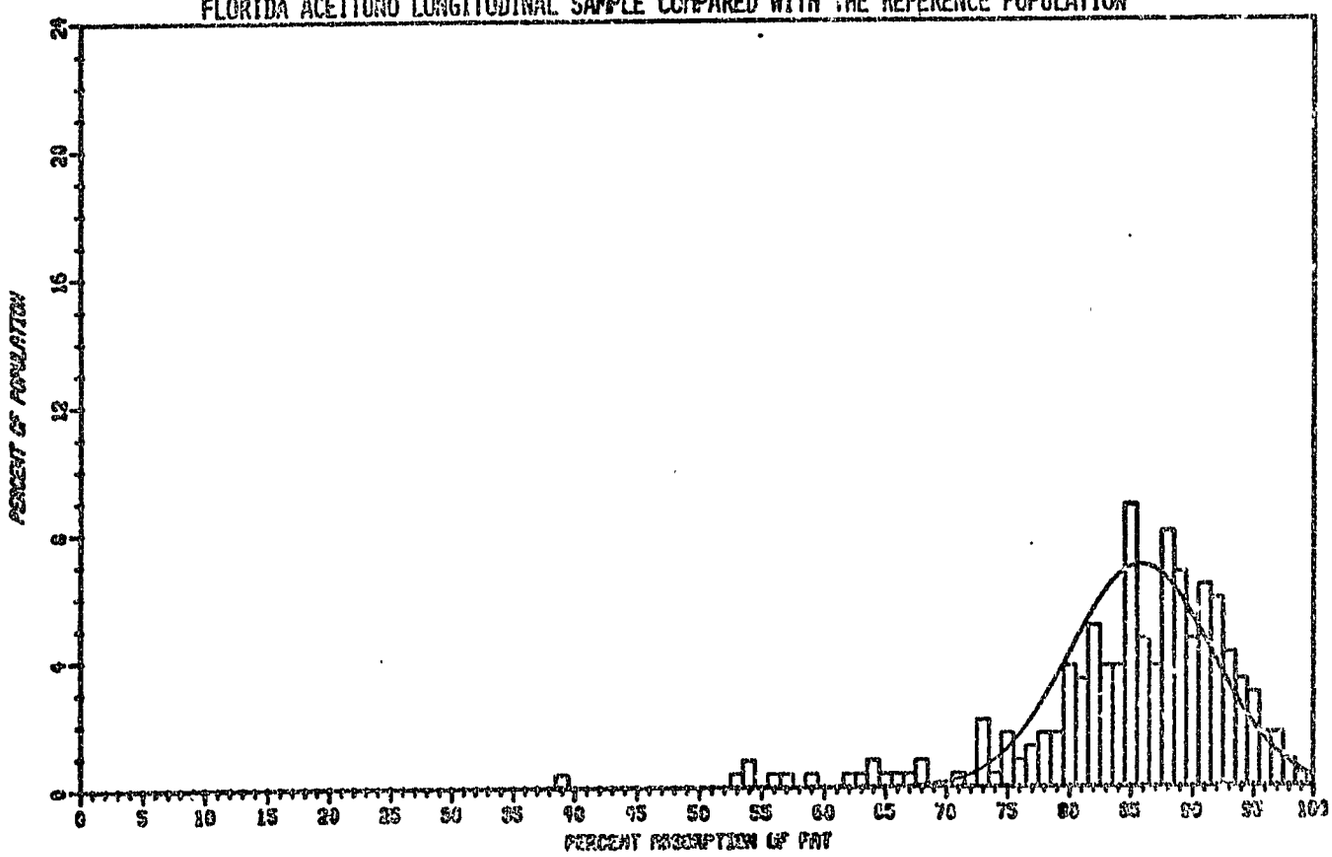
HISTOGRAM VII.41

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1975 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



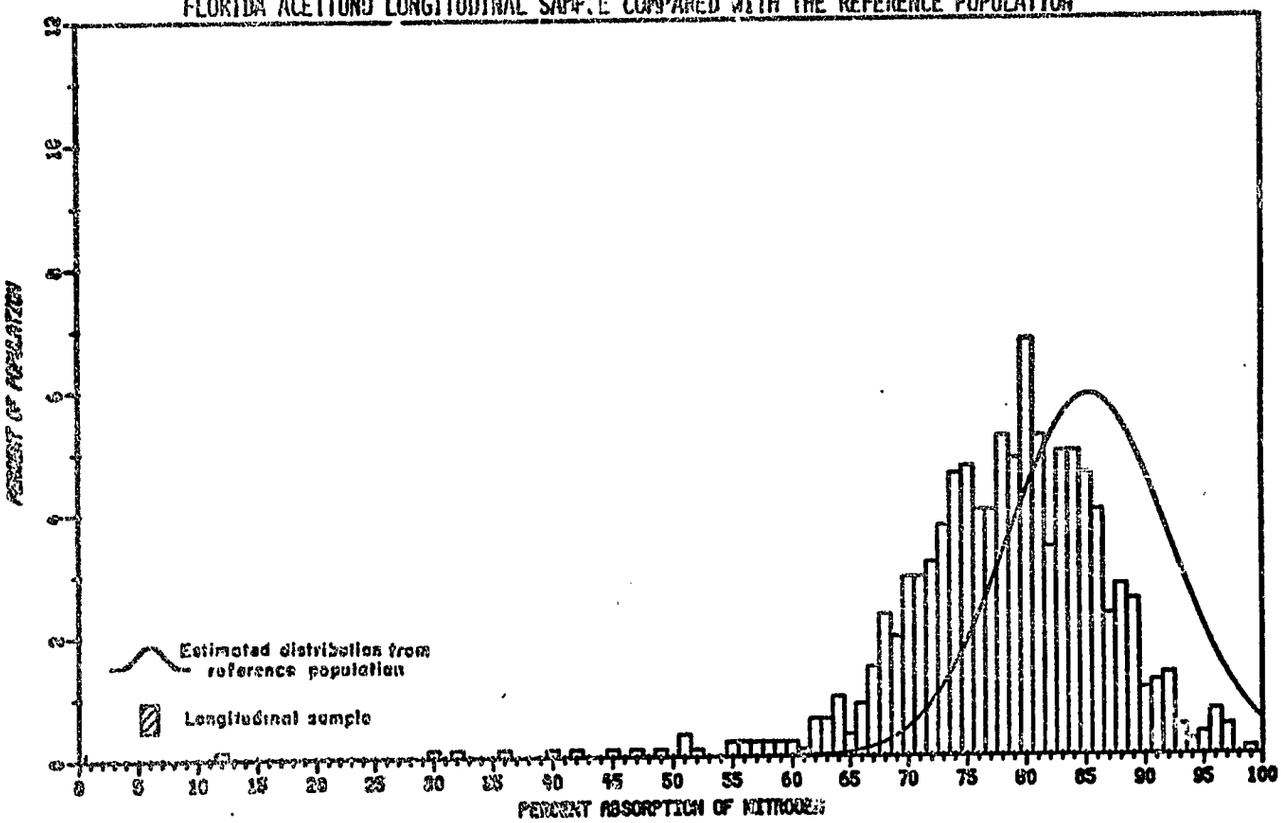
HISTOGRAM VII.42

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1976 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



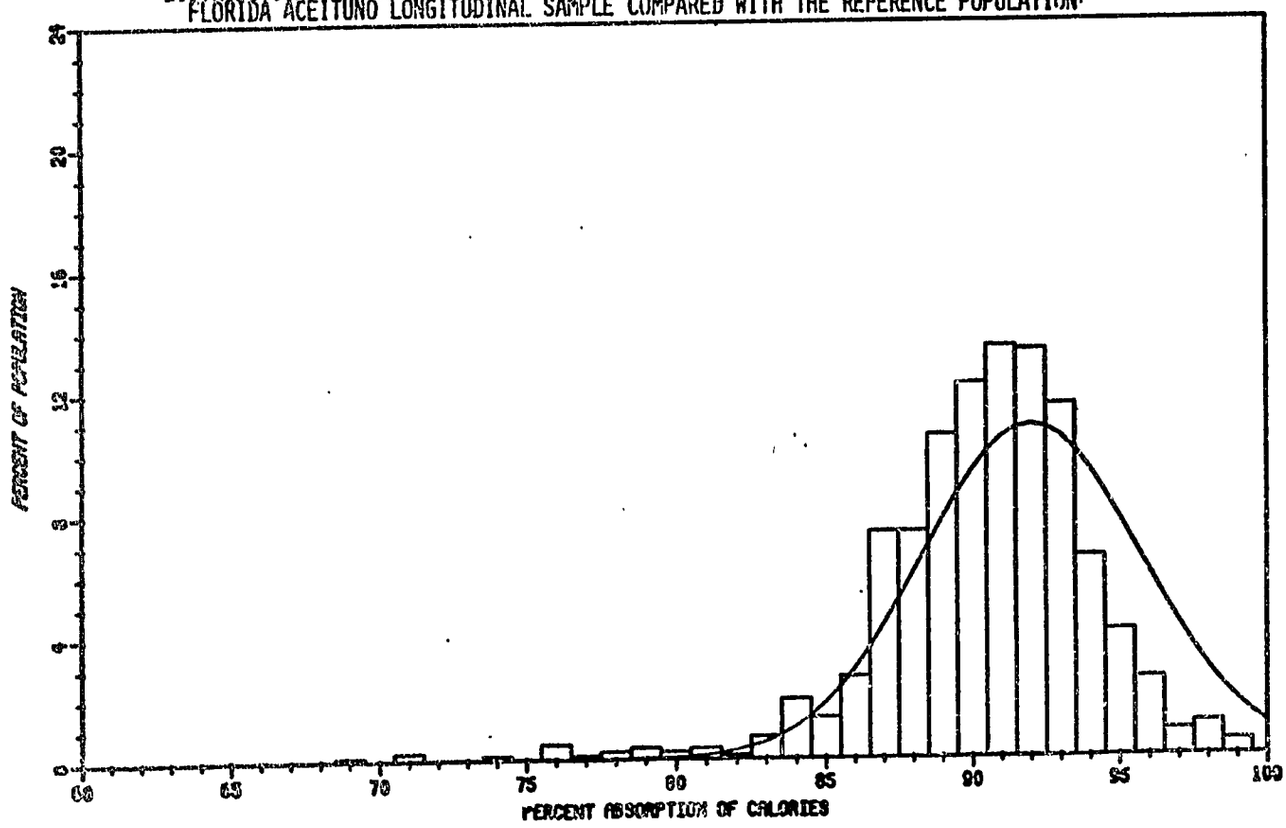
HISTOGRAM VII.43

DISTRIBUTION OF PERCENTAGE ABSORPTION OF NITROGEN IN THE 1973-76 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



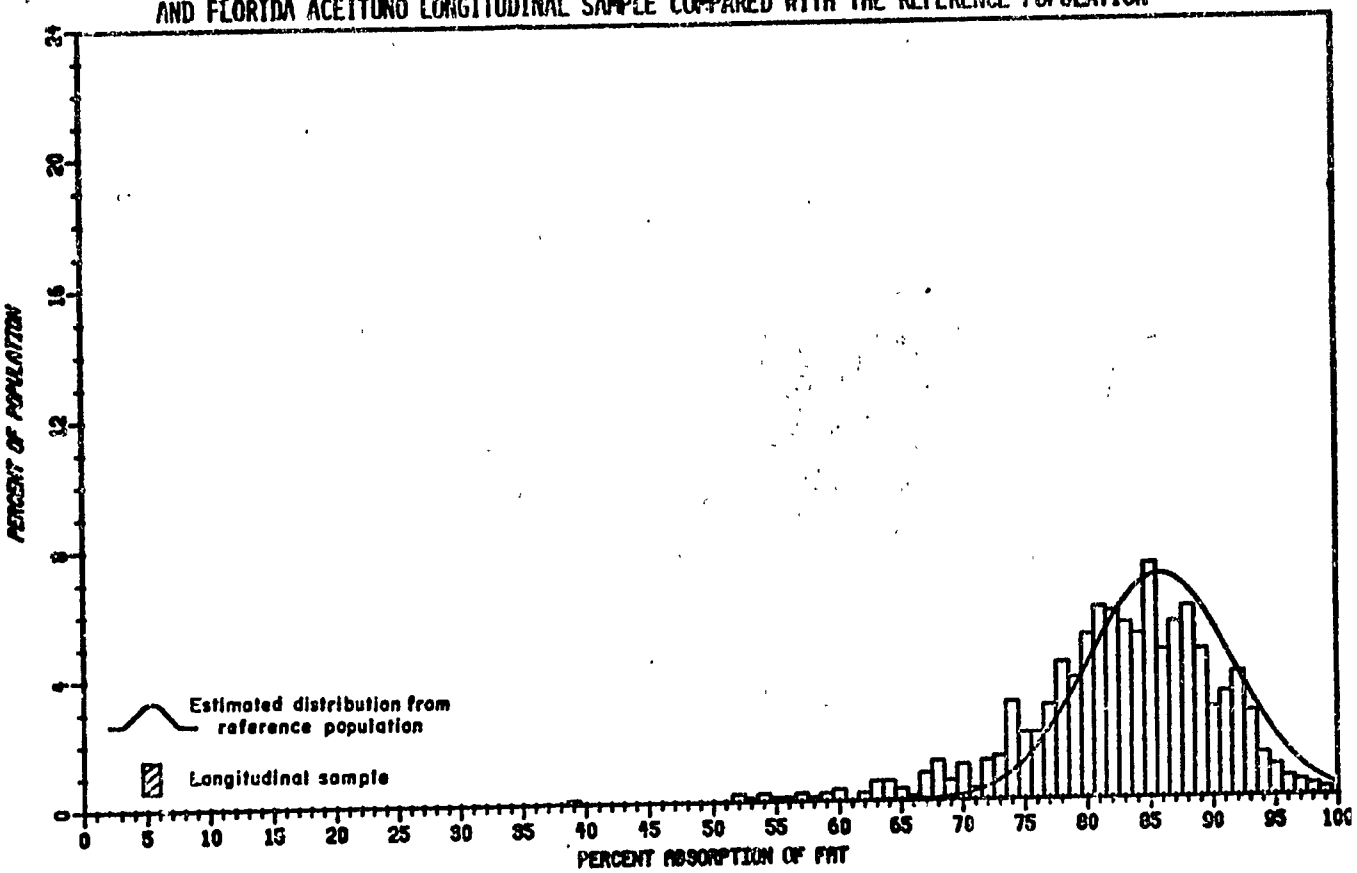
HISTOGRAM VII.44

DISTRIBUTION OF PERCENTAGE ABSORPTION OF CALORIES IN THE 1973-76 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



HISTOGRAM VII.45

DISTRIBUTION OF PERCENTAGE ABSORPTION OF FAT IN THE 1973-76 GUANAGAZAPA AND FLORIDA ACEITUNO LONGITUDINAL SAMPLE COMPARED WITH THE REFERENCE POPULATION



A plot of the normal distribution curve, derived from the distribution of absorption values for the "reference population", has been drawn on each histogram for visual comparison (see Section VI). The normal curves were drawn using standard mathematical formulae and the estimates of means and standard deviations obtained from the "reference population" data. The "reference population" data were discussed extensively in the 1976 annual report of the project. That report presented a discussion of the uncertainty of the location and spread of the normal curves drawn on the histograms. Since the curves are presented as a visual aid, no indication of the uncertainty has been included.

One series of histograms has the combined data from both villages. This series illustrates an annual comparison of absorption among lowland Guatemalan males versus the soldier "reference population". The final histograms include data for all four years as compared with the "reference" population.

6. Discussion of the Results

More extensive interpretation of the results will be presented in the third report of the project (policy implications) and following further iterations to further reduce the errors noted in the data.

There is a substantial "balance effect" for percent absorption of nitrogen and calories during the second three-day balance compared to the first three-day balance. This effect complicates comparison of later years with 1973 in which only one balance was performed. Also, the first balance in 1974 was different from all the others. In this balance, each subject's total caloric intake was adjusted to one of three levels in an attempt to approximately match the subject's pre-metabolic ward intake. Therefore, it is reasonable to ask if the drop from Balance I

to Balance II appears to be slightly larger in 1975 than in 1974. This difference is not significant. The Balance I to Balance II drop in 1976 is unusual. The drop for Guanagazapa subjects was substantially larger than for Florida Aceituno subjects. The "balance effect" was not consistent for fat or d-Xylose absorption.

Both Florida Aceituno and Guanagazapa subjects showed an increase in the absorption of nitrogen for the first three years if the "balance effects" are ignored. The increase is slightly more acute in Florida Aceituno than in Guanagazapa. The absorption of nitrogen in both groups levelled off at essentially the same level from 1975 to 1976. In the absorption of calories, the Guanagazapa group showed a slightly increasing trend over the four years of the study while the Florida Aceituno subjects showed mixed increases and decreases. It is doubtful that any significance should be attached to either result or in the comparison of the two.

The results for the percentage absorption of fat are similarly mixed. Guanagazapa subjects had a high 1973 level of fat absorption which dropped in 1974 and returned in following years to essentially the initial level. Florida Aceituno subjects began at an initially low level and generally increased their percentage absorption of fat to approximately the same level as the Guanagazapa subjects by 1976. This "trend", as the others, is too short to be considered a real trend or to be of real significance.

The percentage absorption of d-Xylose also showed mixed results, decreasing from 1973 to 1974 in Guanagazapa subjects and then increasing in the following two years. The results for Florida Aceituno subjects fluctuated. Absorption of d-Xylose appears to have shown less "balance effect" than for the other variables.

Figures VII.6 to VII.9 present the results for the "longitudinal

sample", that is the subjects who participated in all four annual metabolic studies. These subjects show essentially the same patterns as seen in the results from the data computed on all subjects. One would expect this result since the "longitudinal sample" subjects comprise a majority of the total subjects in each year's data.

Tables VII.14 and VII.15 show two types of correlations which are of interest in this study. The first presents the correlations between absorption of nitrogen, calories, fat, and d-Xylose, adjusted for other effects (Table VII.14). This adjustment is important since adjusted correlations do not contain extraneous effects such as village, year or balance effects which would be included in simple correlations. The correlations between percent absorption of nitrogen, calories, and fat are quite high. These are on the order of 0.4 to 0.8. However, the correlations between d-Xylose and nitrogen, calories, and fat are 0.20, 0.19, and 0.13, respectively. These correlations are all statistically significantly different from zero at the 0.05 level. The practical significance of the correlations with d-Xylose remains to be demonstrated.

Table VII.15 presents the estimates of correlations between similar measurements made on the same subject in successive years. An example is the correlation between percent absorption of nitrogen measured in Balance A in 1974 and percent absorption of nitrogen measured in successive balances ('74B, '75A, '75B, '76A, and '76B). These measurements are shown in the first line of the table to be 0.32, 0.34, 0.25, 0.06, and 0.31 respectively.

The correlations show that the percentage absorption of nitrogen is quite variable from balance to balance as well as from year to year. Correlations between successive balances in one year are on the order of 0.2 to 0.3. Correlations between measurements on successive years fall

TABLE VII.14

Correlation Coefficients for Percent Absorption of d-Xylose, Nitrogen, Calories and Fat (Adjusted for village, year, balance effects and age of subject)

Component	d-Xylose	Nitrogen	Calories	Fat
d-Xylose	1	0.20	0.19	0.13
Nitrogen	0.20	1	0.80	0.41
Calories	0.19	0.80	1	0.46
Fat	0.13	0.41	0.46	1

Note: These estimates are based on 804 degrees of freedom.

TABLE VII.15

Correlations Among Similar Measurements Made Over Three Years and Six Balances

I. Percent Absorption of Nitrogen

Year Balance	1974 A	1974 B	1975 A	1975 B	1976 A	1976 B
1974A	1	0.32	0.34	0.25	0.06	0.31
B	0.32	1	0.14	0.23	0.04	0.16
1975A	0.34	0.14	1	0.29	0.22	0.31
B	0.25	0.23	0.29	1	0.17	0.18
1976A	0.06	0.04	0.22	0.17	1	0.19
B	0.31	0.16	0.31	0.18	0.19	1

II. Percent Absorption of Calories

1974A	1	0.36	0.26	0.16	-0.02	0.33
B	0.36	1	0.12	0.27	0.16	0.23
1975A	0.26	0.12	1	0.11	0.14	0.23
B	0.16	0.27	0.11	1	0.16	0.21
1976A	-0.02	0.16	0.14	0.16	1	0.20
B	0.33	0.23	0.23	0.21	0.10	1

III. Percent Absorption of Fat

1974A	1	0.27	0.27	-0.07	-0.21	0.00
B	0.27	1	-0.02	-0.12	-0.15	0.10
1975A	0.27	-0.02	1	0.26	-0.10	-0.14
B	-0.07	-0.12	0.26	1	-0.03	-0.08
1976A	-0.21	-0.15	-0.10	-0.03	1	0.29
B	0.00	0.10	-0.14	-0.04	0.29	1

Note: Correlations were computed from the error sums of squares and cross products matrix from a full rank general linear multivariate model which included, as mean effects: village, height, weight and age of subjects. The estimates are based on 93 degrees of freedom. Data were included from all subjects with complete data for the six balances indicated, including 46 from Florida Aceituno and 52 from Guanagazapa.

in the same range, while correlations between measurements two years apart range from 0.04 to 0.31.

The percentage absorption of calories exhibits even more random variation and generally less correlation among successive measurements. Within year balance-to-balance correlations are approximately 0.1 except for 1974. Between year correlations fluctuate widely from -0.02 (essentiall zero) to 0.33.

The percentage absorption of fat exhibits less consistency than calori from year to year, with correlations ranging from -0.21 to -0.02. The absorption of fat is relatively consistent (relative to nitrogen and calori Successive balances for fat within a year have correlations varying from 0.26 to 0.29.

The general conclusion from these results is that there is some consistency of percent absorption of nitrogen, calories, and fat from year to year. However, for most practical purposes, knowledge of a subject's absorptive capacity in one year provides little information on the subject' capacity the next year or the preceding year.

Technical Note

All the results presented in Tables VII.6 to VII.13 and Figures VII.2 to VII.9 are based upon computations from a general linear univariate model in which each observation was entered as an independent unit. In effect, different linear models were fitted for the different variables for percent absorption of nitrogen, calories, fat and d-Xylose. The analysis was performed separately for all subjects and for the longitudinal sample.

All standard errors and significance computations were based upon a pooled estimate of the variance (presented at the foot of each table) and the corresponding pooled degrees of freedom.

Previous experience and analysis have shown that there are small positive correlations between successive measurements on the same subject. One of the assumptions underlying the computation of significnace levels in the tables is that such observations are independent. This assumption tends to make standard errors appear slightly too small and the significance levels appear slightly greater than they really should be.

D-Xylose Absorption Studies

The d-Xylose absorption test is the most commonly used test of intestinal function throughout the world. In structure, d-Xylose is a 5-carbon monosaccharide which is absorbed by the same transport system as hexose, glucose and galactose. It is relatively poorly absorbed and not broken down in the body. Csaky presented evidence that d-Xylose is actively transported from the lumen of the intestine. The work of Isselbacher and Senior indicates that probably as much as 60% of the d-Xylose absorbed is metabolized. Nevertheless, the appearance of xylose in the blood following oral ingestion reflects the intestine's capacity to absorb the pentose and provides useful information regarding the functional integrity of the intestinal mucosa. The appearance of ingested xylose in the urine depends upon normal renal function.

Several investigators have pointed out the limitations of this test. These limitations include:

a. Normal excretion of xylose decreases with age, particularly in patients over 50 years of age.

b. Vomiting or delayed gastric emptying can lead to low urinary xylose values.

c. Inadequate hydration, decreased effective circulating volume, renal disease, and the presence of massive ascites can lead to a decreased urinary clearance of xylose and a low xylose excretory value.

Very low values for xylose excretion, as little as 2.5 grams per 5-hours, may be seen in the presence of a massive bacterial overgrowth in the proximal small intestine. This is caused by the uptake and metabolism of xylose by the organisms. Low values are also seen in disease states when there is a significant loss of the functional integrity of the jejunum. In spite of a large number of surveys and research studies, it has been difficult to accurately evaluate the usefulness of this test. This difficulty is due primarily to the fact that the test has undergone numerous modifications, not only in the oral test dose of d-Xylose, but also in other methodological aspects. One of the objectives of this project was to assess the significance and usefulness of this test in evaluating gastro-intestinal function at the population level. Another objective was to further investigate whether the presence of d-Xylose malabsorption, in a given subject, actually reflects food malabsorption and, if so, to what extent.

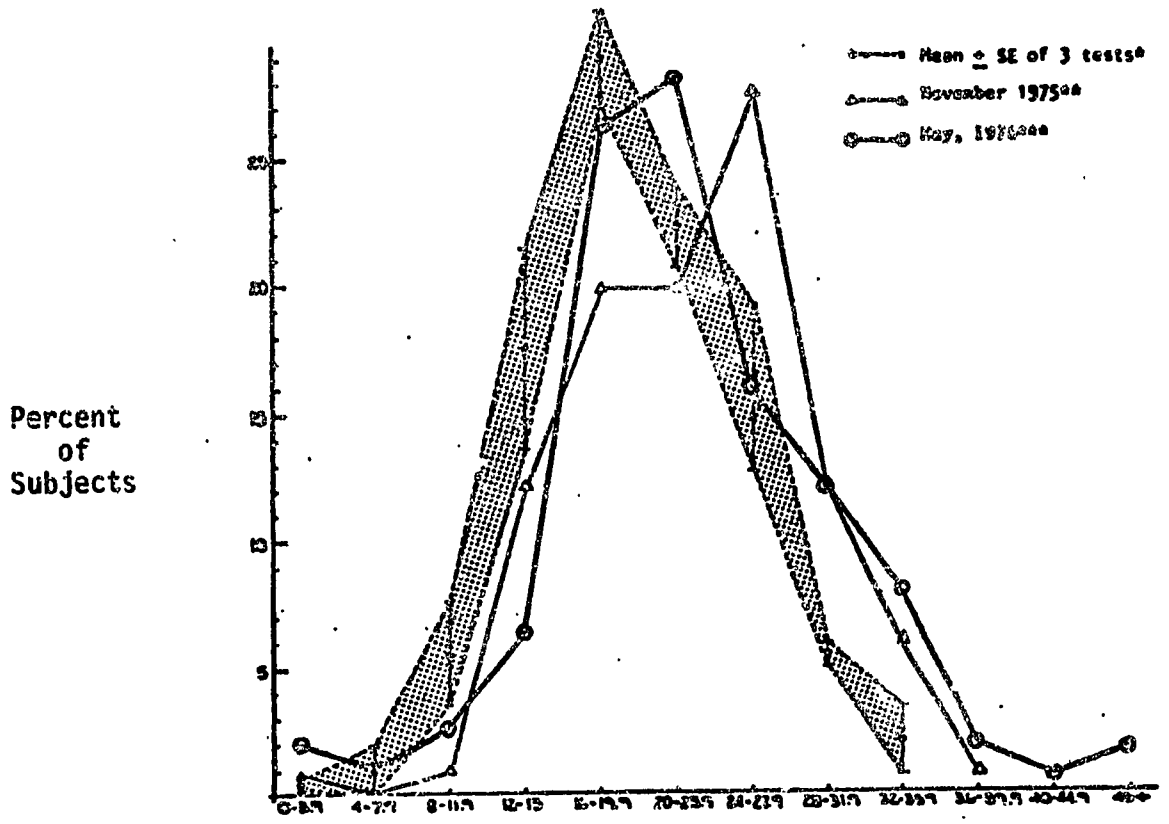
Starting in November 1972, d-Xylose absorption tests were performed in adult males in the two study communities and this continued during May and November in each study year. The protocol for d-Xylose testing was presented in the Methodology Report. Two other groups of males were also studied. These were military academy students (in 1972 and 1974) and healthy soldiers from the rural areas of Guatemala who had been living in military barracks near the capital city for a period of two years prior to the performance of the absorpiton test (1974). The distribution of d-Xylose excretion in subjects from Guanagazapa and Florida Aceituno are given in Figures VII.10 and VII.11

A summary of the results of d-Xylose testing include:

1. The prevalence of d-Xylose malabsorption (below 16% of the oral

FIGURE VII.10

D-Xylose Absorption In Adult Males In Guanagazapa



5 Hour d-Xylose Urinary Excretion (%)

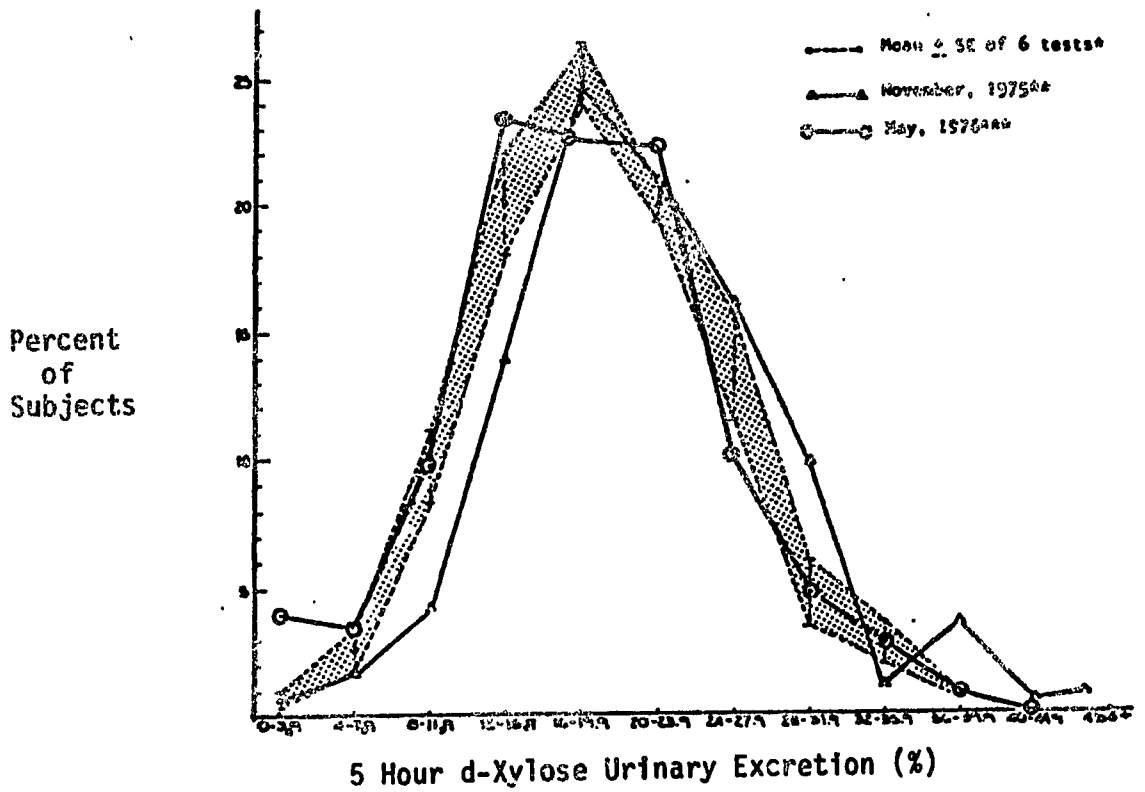
*Tests performed in October 1972, April 1973, May 1975.

**116 subjects

***95 subjects

FIGURE VII.11

D-Xylose Absorption In Adult Males In Florida Aceituno



*Tests performed in August 1972, May-June 1973, November 1973, April 1974, November 1974, May 1974.

**162 subjects

***151 subjects

dose) fluctuated between 29 and 31%.

2. Seven to 10% of the students of the military academy were malabsorbers based on the same criteria. Furthermore, d-Xylose absorption was higher in cadets than in the rural subjects studied (Figure VII.12).

3. The incidence of d-Xylose malabsorption in the soldiers studied in 1974 was 9% and the distribution curve was similar to that observed in the military academy students (Figure VII.12).

As can be seen in Figure VII.13 in November 1975, the distribution curve of d-Xylose absorption of individuals from Guanagazapa moved to the right while that of Florida Aceituno remained fairly stable. In the May 1976 test series, the absorption curve from Guanagazapa indicated that d-Xylose absorption had improved while that of Florida did not show any significant change compared to the curves of previous years.

A difference was also observed (Figure VII.14) among the rural subjects, students of the military academy, and soldiers when they were divided into low (d-Xylose absorption below 16%), intermediate (16-19.9% absorption), and normal absorbers (above 20% absorption). Up to May 1975, the percentage of low absorbers in both communities remained fairly stable around 30%. However, during the test series in November 1975 and May 1976, the mean capacity of subjects from Guanagazapa to absorb d-Xylose did improve and equalled that observed in the students of the military academy and soldiers. The absorptive capacity of subjects from Florida Aceituno, however, did not change.

Seven surveys were made to estimate the mean percentage of d-Xylose absorption. The results are summarized in Table VII.1 and Figure VII.15. The differences in absorption between communities were small in the early surveys but quite large in the final two surveys. However, the substantial year-to-year variability in community means cast doubt on the real

FIGURE VII.12

Comparison of D-Xylose Absorption in Adult Males
Living Under Village and Improved Sanitation Conditions
(1972 to 1974)

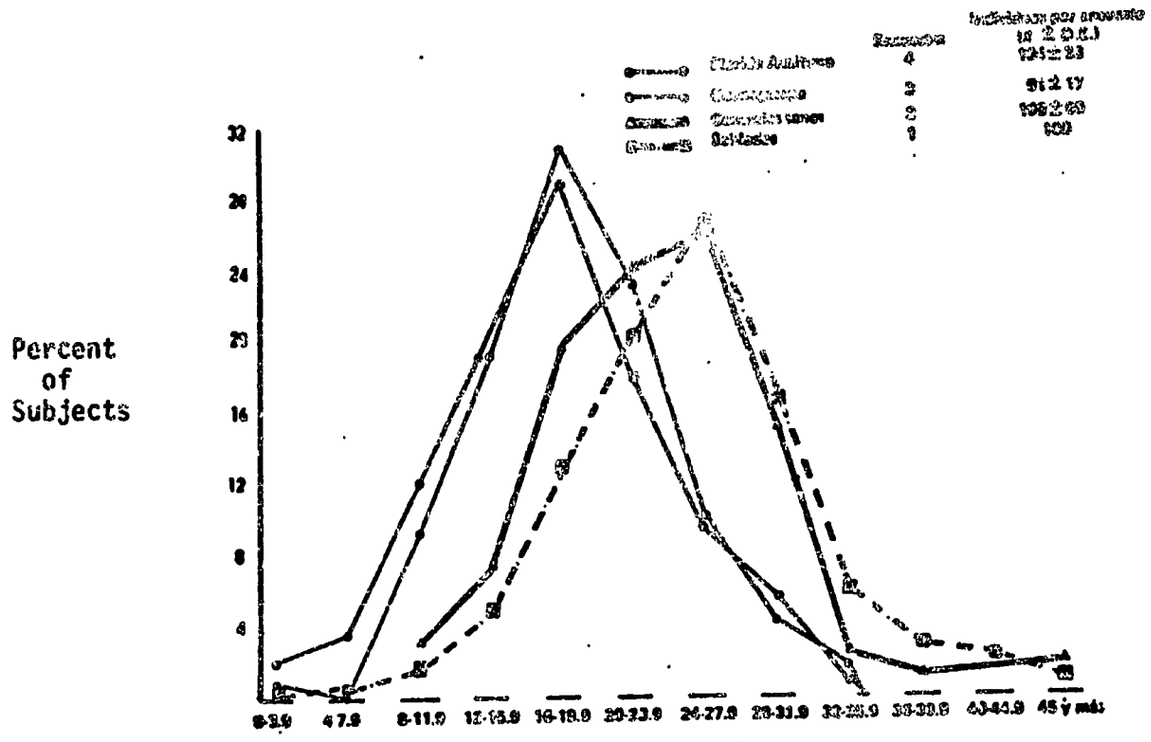
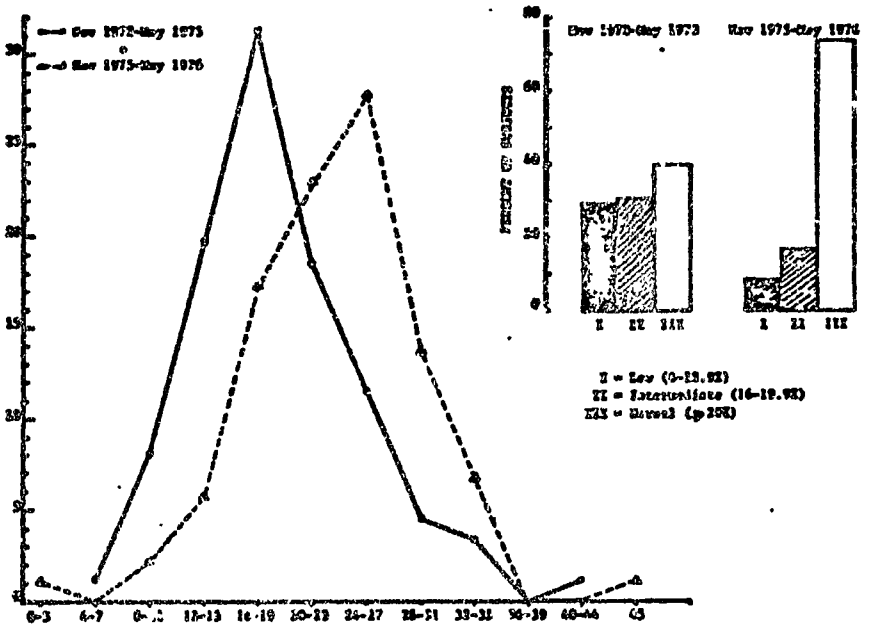


FIGURE VII.13

Comparison of d-Xylose Absorption In Adult Males
Over Two Time Periods

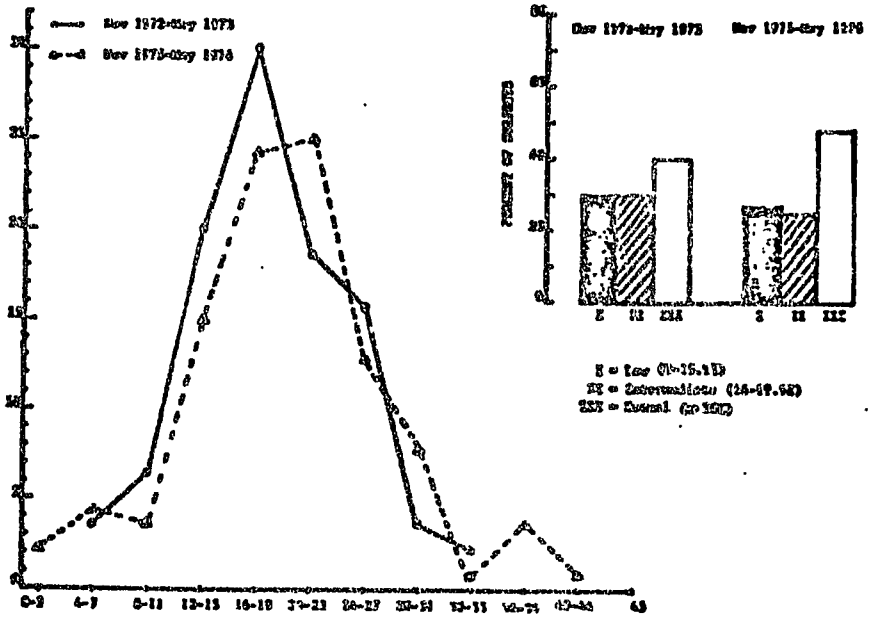
Guanagazapa

Percent
of
Subjects



Florida Aceituno

Percent
of
Subjects



5 Hour d-Xylose Urinary Absorption (%)

FIGURE VII.14

Mean Number of Individuals With Low, Intermediate, and Normal Xylose Absorption (1972 to 1976)

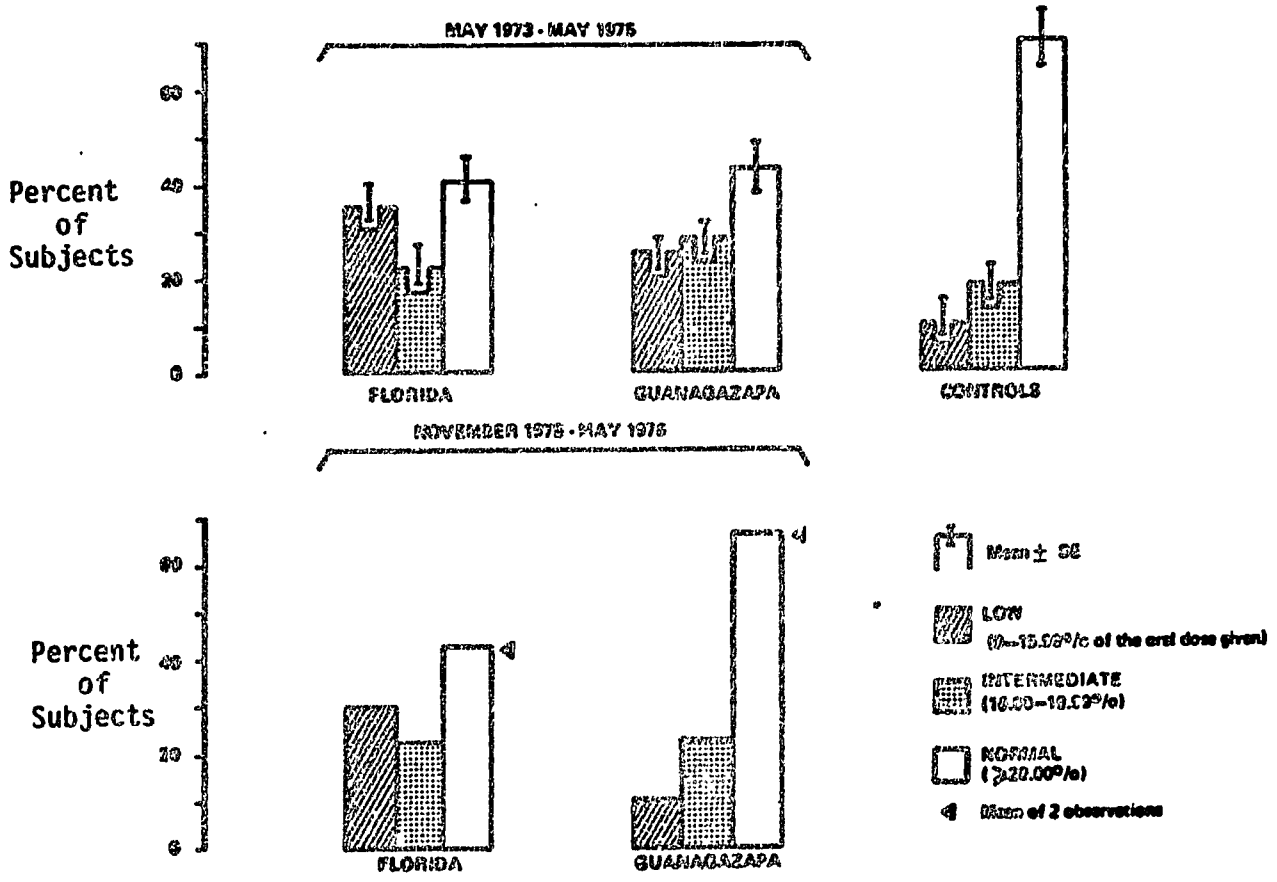


TABLE VII.1

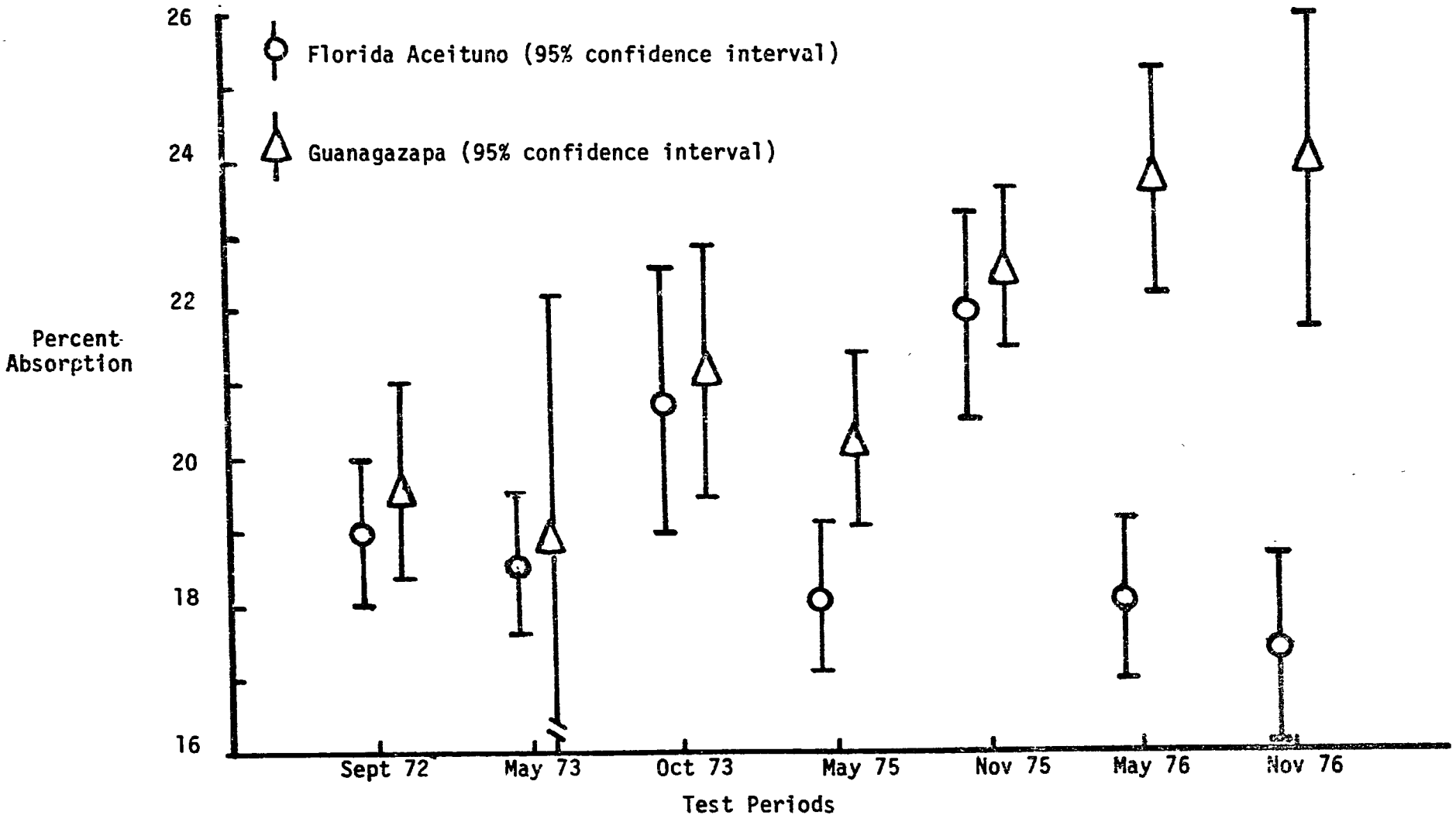
Mean D-Xylose Absorption In Adult Males From Florida Aceituno and Guanagazapa (1972-1976)

Test Period	Village	Percent Absorption*	Standard Error	Number of Subjects
Sept-Oct 1972	FA	19.01	0.50	137
	GU	19.67	0.64	106
May 1973	FA	18.61	0.44	172
	GU	18.87	1.66	17
Oct-Nov 1973	FA	20.70	0.89	56
	GU	21.17	0.85	48
May 1975	FA	18.09	0.52	144
	GU	20.24	0.60	106
Nov 1975	FA	22.02	0.65	157
	GU	22.52	0.54	115
May 1976	FA	18.10	0.58	143
	GU	23.68	0.84	95
Nov 1976	FA	17.42	0.66	82
	GU	23.77	1.03	75

*Of the oral dose administered.

FIGURE VII.15

Mean D-Xylose Absorption In Adult Males In Florida Aceituno and Guanagazapa (1972-1976)



significance of the differences in the last two surveys. The apparent trend might or might not persist over future surveys, if they were performed.

The d-Xylose test is based on the assumption that the subjects' capacity to absorb d-Xylose is indirectly measuring gastrointestinal bacterial overgrowth and this might be related to the degree of sanitation prevailing in the environments where these subjects live. Obviously additional tests are needed before further statements can be made on the association of d-Xylose, bacterial overgrowth and their relation to sanitation conditions.

VIII. Anthropometric and Parasitological Studies

These surveys were scheduled for both study communities during the first and last year of the project. One hypothesis was that, after the introduction of the sanitary improvements, the population of Guanagazapa would show a decrease in diarrheal disease and an improvement in absorption which would, in turn, be reflected by an improvement in their nutritional status. Anthropometric parameters are considered to reflect nutritional status. Therefore, a beneficial change could be expected to occur in the period between the first and the last surveys, especially in children. A related hypothesis was that the availability of water and changes in sanitation would lead to a decrease in intestinal parasitism in the population of the improved community. Of course, these hypotheses were optimistic considering the length of the study. The concluding parasite and anthropometry surveys were not done due to the ending of the project earlier than had been planned. Therefore, the only data collected was for the baseline survey.

Baseline Anthropometry Survey

These surveys were carried out in two stages. The first stage was done during August-October 1972 when 523 subjects from Florida Aceituno and 599 subjects from Guanagazapa were studied. The second stage was performed during the period of June-September 1973 when another 439 and 307 subjects were studied from Florida Aceituno and Guanagazapa respectively.

Figure VIII.1 presents the mean and standard deviation of the anthropometric measurements of male and female children from 1 to 6 years old. Tables VIII.1 and VIII.2 are the results obtained in older subjects. These results are similar to those in other groups of rural Guatemalans studied

FIGURE VIII.1

Height-For-Age and Weight-For-Height Indices In Children
From Two Rural Villages In Guatamala
(9 to 72 Months of Age)

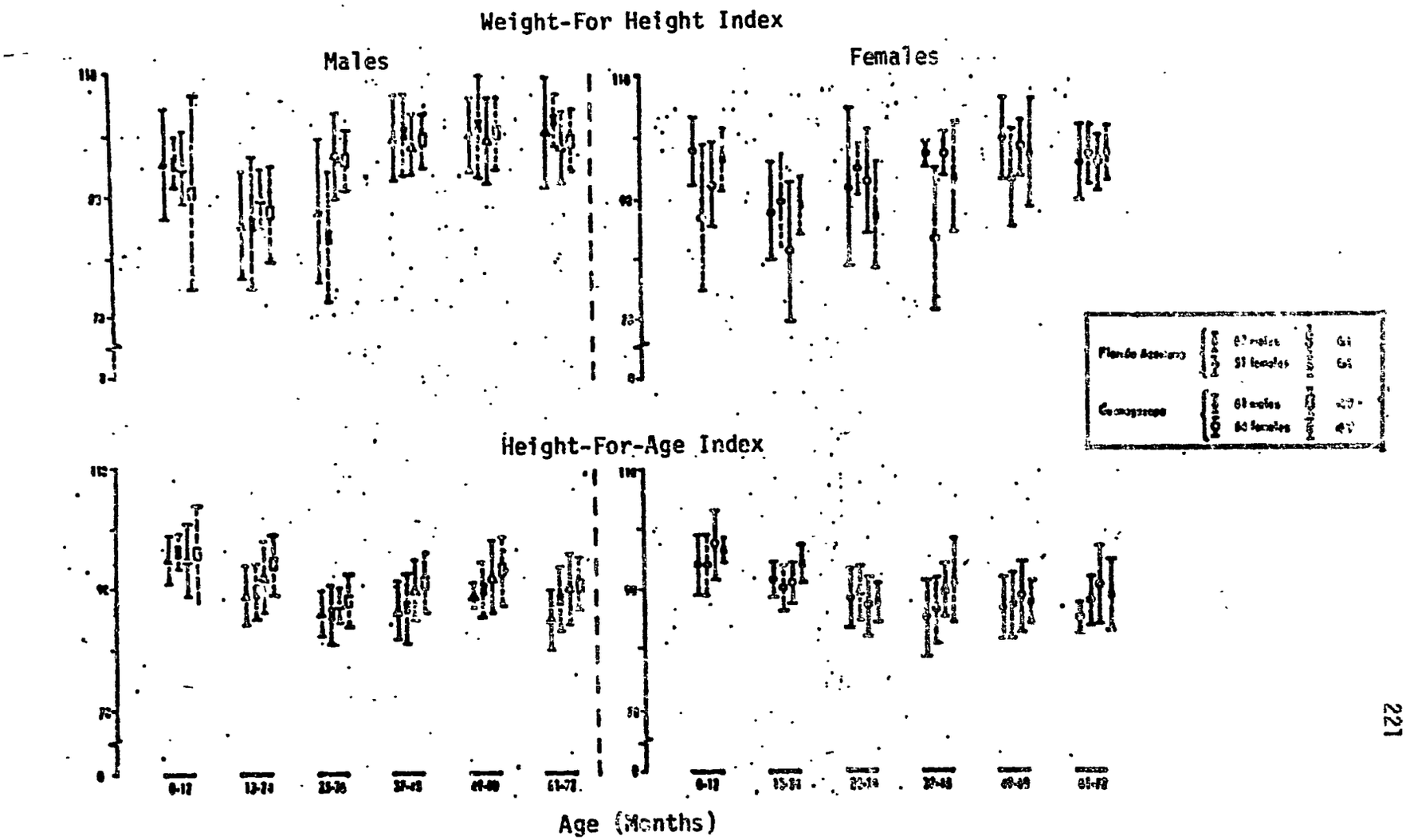


TABLE VIII.1

Anthropometric Measurements of Individuals From Guanagazapa

Males

	1 9 7 2					1 9 7 3				
Age (years)	Number of Individuals	Height (cm)	Weight (kg)	Arm circumference (cm)	Arm Skinfold (mm)	Number of Individuals	Height (cm)	Weight (kg)	Arm circumference (cm)	Arm Skinfold (mm)
7-10	35	123.89 (10.7)*	23.25 (5.37)	16.98 (1.4)	5.13 (1.49)	28	119.35 (6.5)	22.23 (3.67)	16.60 (1.3)	4.96 (1.87)
11-15	37	140.02 (10.7)	34.37 (9.45)	19.84 (2.7)	6.88 (4.33)	34	139.25 (10.5)	32.79 (4.64)	18.83 (1.7)	7.19 (2.67)
16-20	33	161.05 (9.8)	51.40 (8.71)	24.18 (2.3)	5.38* (1.58)	15	157.44 (6.7)	50.57 (7.82)	23.16 (2.1)	7.48* (1.95)
21-25	12	162.79 (5.7)	54.77 (10.1)	25.55 (3.3)	6.29 (7.21)	14	162.46 (7.1)	56.83 (8.54)	23.29 (2.8)	8.21 (5.46)
26-30	14	162.18 (6.8)	57.09 (4.88)	25.31 (2.3)	6.20 (2.56)	7	163.11 (3.7)	58.64 (4.34)	25.81 (2.2)	5.74 (1.75)
31-35	10	163.17 (3.4)	55.59 (3.89)	25.36 (1.3)	6.18 (1.87)	8	161.54 (4.5)	57.38 (5.24)	25.32 (1.4)	5.9 (1.60)
36-45	22	163.37 (6.1)	58.65 (7.51)	26.14 (2.2)	5.79 (2.30)	15	163.11 (5.6)	58.80 (7.21)	24.67 (1.9)	5.72 (1.77)
>45	28	161.01 (11.1)	56.82 (10.1)	25.57* (2.6)	6.76 (4.27)	21	159.59 (7.3)	53.77 (10.6)	23.66* (2.8)	6.53 (2.76)

Females

	1 9 7 2					1 9 7 3				
Age (years)	Number of Individuals	Height (cm)	Weight (kg)	Arm circumference (cm)	Arm Skinfold (mm)	Number of Individuals	Height (cm)	Weight (kg)	Arm circumference (cm)	Arm Skinfold (mm)
7-10	51	131.63* (8.9)*	22.72 (3.68)	17.08 (1.5)	6.93* (2.12)	40	117.65* (7.9)	21.84 (3.37)	16.72 (1.5)	6.45* (1.90)
11-15	38	141.70 (8.7)	33.90 (8.24)	20.82 (2.7)	8.99 (4.03)	28	138.74 (9.3)	33.79 (9.34)	19.34 (2.5)	10.37 (3.17)
16-20	20	150.03 (5.9)	44.43* (3.84)	23.10 (1.6)	10.13* (4.43)	12	150.50 (7.4)	47.68* (4.21)	23.56 (1.7)	11.59* (4.53)
21-25	25	151.82 (5.9)	49.43 (7.00)	24.95 (2.1)	13.01 (6.54)	14	151.33 (4.9)	50.38 (3.35)	24.44 (1.7)	15.33 (4.29)
26-30	12	148.30 (5.0)	50.91 (12.5)	25.22 (2.2)	13.25 (5.14)	9	148.36 (4.4)	47.67 (6.71)	24.81 (2.1)	15.41 (5.77)
31-35	16	152.29 (4.9)	49.07 (4.84)	24.34 (1.5)	10.20* (3.16)	12	149.57 (6.3)	49.56 (6.78)	23.75 (1.9)	13.66* (3.06)
36-45	36	150.58 (4.9)	51.62 (8.51)	26.01* (3.0)	12.05 (5.80)	23	150.29 (5.0)	49.64 (6.81)	24.21* (2.4)	13.87 (5.93)
> 45	34	148.30 (6.6)	43.68 (10.7)	23.53* (3.2)	11.34* (5.97)	23	146.35 (4.2)	47.41 (9.78)	24.11* (2.7)	14.17* (5.53)

*Mean±Standard Deviation ( ).

TABLE VIII.2

Anthropometric Measurements of Individuals From Florida Aceituno

Males

Age (years)	1972 Number of Individuals	1972 Height (cm)	1972 Weight (kg)	1972 Arm circumference (cm)	1972 Arm Skinfold (mm)	1973 Number of Individuals	1973 Height (cm)	1973 Weight (kg)	1973 Arm circumference (cm)	1973 Arm Skinfold (mm)
7-10	35	117.79 (12.7)*	21.43 (3.35)	16.75 (1.2)	5.92 (1.45)	34	110.09 (8.5)	21.14 (22.2)	16.41 (1.1)	6.30 (2.51)
11-15	25	135.10 (10.4)	30.92 (7.65)	18.71 (2.4)	6.19 (2.10)	23	133.38 (12.2)	31.87 (9.42)	19.58 (4.4)	6.30 (2.71)
16-20	30	154.75* (7.7)	47.23 (7.25)	23.20* (2.5)	5.50 (1.68)	37	158.21* (10.7)	43.70 (8.96)	27.26* (2.5)	4.87 (3.56)
21-25	18	156.63 (6.8)	50.99 (8.19)	24.25 (2.0)	6.12 (2.55)	8	154.68 (7.4)	52.28 (8.54)	23.88 (2.4)	5.44 (1.72)
26-30	13	153.86 (5.1)	54.07 (7.78)	25.22 (1.54)	5.08 (1.39)	9	159.61 (4.3)	53.00 (4.19)	24.38 (1.1)	4.79 (1.05)
31-35	18	152.16 (6.6)	53.91 (6.28)	25.44* (1.7)	5.00 (1.25)	16	157.39 (7.6)	52.59 (4.50)	24.37* (1.5)	4.93 (1.76)
36-45	37	154.35 (17.9)	53.45 (10.4)	25.29 (2.9)	5.59 (2.52)	19	153.70 (5.9)	52.23 (6.29)	22.66 (4.3)	5.00 (4.26)
> 45	45	156.31 (6.5)	51.84 (13.3)	24.26 (2.1)	5.10 (1.96)	23	159.08 (4.9)	53.09 (6.07)	23.65 (1.9)	5.37 (2.71)

Females

Age (years)	1972 Number of Individuals	1972 Height (cm)	1972 Weight (kg)	1972 Arm circumference (cm)	1972 Arm Skinfold (mm)	1973 Number of Individuals	1973 Height (cm)	1973 Weight (kg)	1973 Arm circumference (cm)	1973 Arm Skinfold (mm)
7-10	31	114.06 (9.5)*	20.09 (3.18)	16.50 (1.1)	7.25 (1.59)	31	115.80 (9.9)	20.60 (4.09)	16.17 (1.3)	7.17 (2.15)
11-15	22	137.11 (11.3)	32.33 (8.69)	20.19 (2.5)	10.05 (3.78)	19	134.63 (9.2)	32.21 (7.98)	19.56 (2.6)	9.22 (4.37)
16-20	27	148.60 (5.8)	45.45 (4.62)	23.47 (1.0)	11.83 (4.99)	28	147.66 (5.0)	48.28 (10.0)	22.56 (1.0)	9.57 (3.34)
21-25	18	146.88* (4.0)	45.53 (5.31)	23.44 (1.7)	10.59 (3.22)	22	142.85* (5.4)	73.16	23.02 (1.8)	9.06 (2.0)
26-29	15	145.76 (5.1)	43.36 (4.40)	24.64* (1.3)	12.00* (3.70)	17	146.29 (4.8)	49.98 (5.66)	23.21* (1.5)	10.11* (2.84)
31-35	16	146.23 (4.9)	46.88 (6.9)	24.35* (2.4)	11.27* (4.74)	12	144.35 (5.9)	46.39 (6.04)	22.96* (1.7)	8.74* (2.41)
36-45	29	148.39 (5.4)	47.02 (7.05)	24.31 (2.4)	10.77 (3.42)	19	147.82 (6.7)	47.30 (6.65)	23.11 (1.9)	15.80
> 45	33	145.93 (6.8)	43.43 (6.49)	23.43 (2.1)	9.95 (3.88)	25	145.91 (5.3)	44.70 (6.35)	22.85 (2.0)	8.84 (3.41)

*Mean ± Standard Deviation ( ).

by other investigators. The indices of weight-for-height (W-H) and height-for-age (H-A) during the first year of life, in both sexes, are within normal limits. Both indices showed a drop during the second and third years of life. The first drop occurred in the weight-for-height index (W-H). This change was seen in both males and females during the 13-24 months period which is coincident with weanling. The drop may be attributed to a prolonged exposure to a highly contaminated environment and to an increase in diarrhea and infectious diseases. In males, the W-H index seems to improve after three years of age and remain stable up to school age. This improvement takes longer in females. The reasons for this difference are unknown. The drop in the H-A index of females occurs after two years (roughly 1 year after the drop in W-H) and although there seems to be some recovery by the fourth year of life, recuperation is not complete.

These observations are in agreement with those of other investigators and demonstrate that children in chronically malnourished populations, who survive the weanling period, do not grow to normal standards for well-nourished children. The deprived children remain short in stature. This adaptation may favor the normalization of the W-H index. The end result is a young and adult population who are shorter but have relatively normal arm circumferences and arm skinfolds. These measurements are shown in Tables VIII.1 and VIII.2. Except for a small tendency for the young adult population from Guanagazapa to have greater arm circumference and tricipital skinfold measurements, no other significant differences were observed in the anthropometric parameters obtained in Florida Aceituno and Guanagazapa.

Parasitology Survey

These surveys were done during the years 1972-1973. Eleven hundred and ninety three subjects were surveyed, 664 in Guanagazapa and 529 in

Florida Aceituno. Only 47 individuals from Guanagazapa (7.0%) and 46 from Florida Aceituno (8.5%) were free of parasites. The other subjects studied harboured one or more intestinal parasites.

The species of parasites found most frequently are shown in Table VIII.3. E. histolytica and G. lamblia were the most common enteropathogeni protozoa found in both communities. The former was more common in Florida Aceituno (140 isolations) than in Guanagazapa (95 isolations). It is still not certain whether the other protozoa found in these subjects are capable of producing damage to the intestines of human beings. In spite of the frequent isolation of these parasites from the stools of the subjects, ther was no significant relationship between their presence and diarrheal episod or evidence of abnormal gastro-intestinal function. The high incidence of parasitism may reflect the degree of contamination of the village environment. Other investigators have suggested that improvements in sanitation and hygienic conditions are associated with a drop in the incide of these parasites.

The three species of helminths most commonly found, in order of frequency, were Uncinaria or Hookworm, T. trichiuris, and A. lumbricoides (Table VIII.3). In other surveys, done during the years 1950-1960, the most frequent intestinal parasite found in subjects living in the lowlands of Guatemala was A. lumbricoides, followed by T. trichiuris and Uncinaria. The change from the 1950's to the 1970's may have been due to the massive use of antihelminthic drugs, such as "Piperazine", during government campa aimed at reducing the incidence of intestinal parasitism. Piperazine is effective against A. lumbricoides but not against Hookworm or T. trichiuri

When the frequency of isolation of intestinal parasites was analyzed according to the age of the subjects (Table VIII.3), it was observed that

TABLE VIII.3

Frequency of Intestinal Parasites In Study Subjects From Both Villages (1972-73)

Guanagazapa

AGE	0-1	2-3	4-6	7-15	16-45	45	TOTAL
No. Subjects	29	54	71	193	198	79	624
PROTOZOA							
E. histolytica	1	2	5	32	44	11	95
E. hartmanni	--	--	1	1	7	--	9
E. coli	4	20	26	89	110	36	285
E. nana	4	7	15	51	70	20	167
I. butschlii	2	8	14	51	63	16	154
D. fragilis	1	--	1	2	4	1	9
T. hominis	--	--	--	--	--	1	1
Ch. mesnili	--	--	1	3	6	3	13
G. lamblia	4	10	9	20	7	3	53
HELMINTHS							
A. lumbricoides	10	41	42	122	101	26	342
T. trichiura	3	34	45	138	102	31	351
Hookworm	3	21	38	133	118	44	367
S. stercoralis	1	1	6	16	9	3	35
E. vermicularis	--	1	--	1	4	--	6
Taenia spp	--	--	--	3	2	1	6
H. diminuta	--	--	1	--	--	--	1
NEGATIVES	14	5	5	5	12	6	47

Florida Aceituno

AGE	0-1	2-3	4-6	7-15	16-45	45	TOTAL
No. Subjects	28	40	51	114	203	93	529
PROTOZOA							
E. histolytica	1	8	9	26	76	20	140
E. hartmanni	--	--	--	3	4	1	8
E. coli	2	7	15	41	108	41	214
E. nana	1	4	6	13	54	13	91
I. butschlii	1	5	10	23	75	22	136
D. fragilis	--	1	1	--	5	--	7
T. hominis	--	--	--	--	7	--	7
Ch. mesnili	1	4	2	2	10	1	19
G. lamblia	1	11	9	16	12	--	49
HELMINTHS							
A. lumbricoides	6	16	24	58	79	30	213
T. trichiura	1	14	43	61	75	38	222
Hookworm	3	19	34	81	149	69	355
S. stercoralis	--	--	2	4	11	2	19
E. vermicularis	--	--	--	--	1	--	1
Taenia spp	--	--	--	1	--	--	1
H. diminuta	--	--	--	--	--	1	1
NEGATIVES	18	3	4	4	9	8	46

48% of the children under 1 year of age from Guanagazapa and 64% of children of the same age from Florida Aceituno had negative stool examinations. Those children, with positive stool examinations, had multiple infestations with helminths and protozoa. As age increased, the percentage of negative stool examinations decreased with an increase in cases of multiparasitism.

In general, the severity of helminth infection among the population studied can be considered to be mild if judged by the ova counts obtained in 284 stool samples from randomly chosen individuals. These samples were analyzed by the Stoll's concentration method. The results were recorded as mean egg counts:

	Ova/gram Feces
A. lumbricoides	9112 ± 2279*
T. trichiuris	619 ± 268
Uncinaria	1112 ± 384

*mean ± S.D. ova counts/gram of feces

The number of eggs per gram of feces was higher for *A. lumbricoides*. Very few individuals showed egg counts of Uncinaria which are believed to be associated with iron deficiency anemia.

IX. Quality Control In Intestinal Absorption Studies

This chapter describes the quality control employed to assess the accuracy of the chemical analyses used in the food absorption studies.

1. Background and Purpose

The methodology used in these studies to measure intestinal absorption (in both normal subjects and malabsorbers) is well documented. The procedure is directed to obtaining a metabolic balance of food intake and food excretion (intake versus outgo). A balance between food intake and fecal elimination requires that the food actually consumed and the unabsorbed food excreted by the subject be accurately measured by chemical analytical procedures. The objective was to accurately measure nitrogen (protein), fat and calories. If desired, the consumption and elimination of carbohydrates can be approximated by computing the difference between the intake of nitrogen and fat, assuming that the amount of nondigestible fiber is known. The analytical methods included: the Kjeldahl nitrogen procedure for protein; the van de Kamer method for fat; and bomb calorimetry for total calories. These procedures are quite accurate when employed by competent analysts (see Volume I, Methodology). An alternative procedure, using radio-isotopes, was not practical on the scale employed in this study.

A total of 120 individuals from the two villages were admitted to the metabolic ward for 5 1/2 to 6 days in each year of the study. The daily intake of food and the stools of each individual were analyzed for nitrogen (protein), fat, and calories. In addition, blood and urine samples were collected from each individual to ascertain that the individual was not ill. The d-Xylose test was administered, prior to admission to the metabolic ward and during the metabolic balances, to screen for malabsorption.

The total number of samples, including replicates, exceeded 10,000 separate chemical determinations. Under these circumstances, no matter how careful, dedicated, and competent the laboratory personnel, the possibility of error always exists. As pointed out by Whitehead (1), error can be introduced from misreading an instrument, an improperly adjusted instrument, errors in calculation, transfer errors (including the transposing of digits, e.g. 110 to 101), incorrect placement of a decimal point, use of a wrong sample, or use of an incorrectly prepared reagent or standard.

To minimize error and maximize accuracy, both internal and external quality control were utilized in the Guatemalan study. Internal quality control, at the Esquintla metabolic ward and INCAP laboratory, was the responsibility of the INCAP staff. External quality control was carried out in North Carolina. Samples selected at random from the project metabolic ward and INCAP laboratories were independently analyzed by the laboratory of the Department of Animal Sciences at North Carolina State University in Raleigh, N.C.*

A known sample of cottonseed meal, rigorously analyzed by the National Academy of Sciences laboratory (2), was also used as an external control to check the results of both the Guatemala and the UNC laboratories. This procedure is an established and approved methodology to validate the accuracy of the many chemical determinations from which conclusions may be drawn. There are many references to quality control in the Cumulative Index Medicus (particularly Volumes 16, 17, and 18 for 1975, 1976, and 1977). The references listed at the end of this section (1, 3, 4, 5, 6, 7) were obtained from this source and were used to organize the methodology used for both internal

*The analyses were done under the direction of Professor Frank H. Smith, Professor of Animal Sciences in Analytical Chemistry.

and external control. The following guideline (1) was also used in addition to external quality control (Figure IX.1.)

Figure IX.1

Quality Control Schema

Check control material. Has it altered in composition?

If satisfactory, check the standards used.

If satisfactory, check the sampling system. For example, automatic pipettes.

If satisfactory, check the measuring system. For example, spectrophotometer.

If satisfactory, check the calculating system.

If satisfactory, prepare reagents. Try to identify those for which stability may be poor.

If satisfactory, repeat optimal conditions variance.

If satisfactory, check the way in which the method is being routinely performed.

Are instructions being followed carefully?

If there has been a change in precision, check the factors concerned with the analytical process variance. For example, temperatures of reactions, timing, and mixing.

If satisfactory, check if instructions are being rigidly followed by the laboratory staff.

If satisfactory, check the sampling system. For example, pipettes.

If satisfactory, check the measuring system. For example, spectrophotometer.

If satisfactory, check the calculating system.

If satisfactory, check the reagents.

If satisfactory, check the optimal conditions variance.

If satisfactory, check the instructions again. Are they being followed carefully?

TABLE IX.1

1974 Quality Control On Analyses of Metabolic Ward Samples

Food Item	INCAP Identification Number	Calories (Kcal/100 g - Dry weight)				Fat (g/100 g - Dry weight)				Nitrogen (g/100 g - Dry weight)			
		UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.
1. Cheese	303	387.30	362.14	-25.16	6.50	2.57	1.36	- 1.21	47.08	10.93	10.45	- 0.48	4.39
2. Meat (Beef)	304	507.40	497.62	- 9.78	1.93	13.89	4.36	-9.53	68.61	12.71	12.45	- 0.26	2.05
3. Rice	305	440.00	436.73	-3.27	0.74	5.76	1.34	-4.42	76.74	1.34	1.57	+ 0.23	17.16
4. Beans (Black)	306	395.70	371.00	-24.70	6.24	1.28	5.70	+4.42	345.3	4.31	4.44	+0.13	3.02
5. Bread	308	426.21	409.43	-16.78	3.94	6.01	4.96	-1.05	17.47	2.27	2.48	+0.21	9.25
6. Pan Dulce (Sweet Bread)	309	443.00	431.61	-11.39	2.57	10.78	7.60	-3.18	29.50	1.45	1.54	+0.09	6.21
7. Tortilla (Corn)	310	404.80	396.20	- 8.60	2.12	1.83	1.63	-0.20	10.93	1.77	2.04	+0.27	15.25
8. Stools	Bal. 40-1 E 266	490.60	494.15	+ 3.55	0.72	11.96	6.78	-5.18	43.31	5.08	4.81	-0.27	5.31
9. Stools	Bal. 40-1 E 267	449.00	440.10	- 8.90	1.98	12.59	2.54	-10.05	79.83	6.26	6.08	-0.18	2.88
10. Stools	Bal. 40-1 E 268	459.10	436.20	-22.96	5.00	14.40	3.38	-11.02	76.53	7.00	6.73	-0.27	3.86
Mean		440.32	427.02	13.51	-	8.11	3.97	5.03	-	5.31	5.26	0.24	-
Std. Error		12.35	14.32	3.01	-	1.64	0.72	1.56	-	1.26	1.19	0.08	-
t				4.25	-			2.65	-			0.63	-
Significance				p<.01	-			p<.05	-			N.S.	-

2. Application of Quality Control To The Guatemala Project

a. Sampling. Specified samples of food and excreta were selected for analysis at irregular intervals during the metabolic years 1974, 1975 and 1976. No samples were obtained during 1973. However, the procedures developed during 1973 were repeatedly checked and observed. The samples selected were analyzed at the laboratories at INCAP and an aliquot of the same sample analyzed at the control laboratory in the Department of Animal Sciences, North Carolina State University, Raleigh, North Carolina The data obtained from these analyses are shown in Tables IX.1, IX.2, IX.3, and IX.4. As a further check on both laboratories, a sample of cottonseed meal of known composition, obtained from the National Academy of Sciences, was also analyzed. These values are found in Table IX.5.

b. Analytical Procedures. The methods used for the determination of calories, fat and nitrogen at INCAP and the Esquintla ward have been described in detail in the Methodology Report.

(1). Calories. The method used for the determination of calories was bomb calorimetry. The procedure and method employed was that described in Manual No. 130, Parr Instrument Company (8). The bomb calorimeter used at INCAP is the Ballistic Calorimeter, CB-370, manufactured in England by A. Gallenkamp and Company, Ltd.. Using a Ballistic instrument and a Parr procedure theoretically should not affect the results of the determination. A Parr Calorimeter was used in the N.C. State University laboratory for external quality control. In both laboratories, each calorimeter was calibrated before use by the combustion of standard benzoic acid of known caloric value.

(2). Fat. Food and fecal fat was determined by the method of van de Kamer, Huinink and Wegers (9), applying the precautions noted by Braddock

TABLE IX.2

1975 Quality Control On Analyses Of Metabolic Ward Samples

Food Item	INCAP Identification Number	Calories (Kcal/100 g - Dry weight)				Fat (g/100 g - Dry weight)				Nitrogen (g/100 g - Dry weight)			
		UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.
1. Beans (Black)	335	434.36	404.80	-29.56	6.81	1.85	2.11	+0.26	14.05	4.10	3.58	-0.52	12.68
2. Cheese	333	484.14	468.42	-15.72	3.25	2.73	2.79	+0.06	2.20	11.05	10.52	-0.53	4.80
3. Meat (Beef)	331	525.84	490.28	-35.56	6.76	7.88	7.65	-0.23	2.92	13.10	12.87	-0.23	1.76
4. Rice	332	422.36	395.76	-26.61	6.30	7.96	7.68	-0.28	3.52	1.26	1.15	-0.11	8.73
5. Bread	336	461.20	451.07	-10.13	2.20	5.35	5.26	-0.09	1.68	2.36	2.24	-0.12	5.08
6. Pan Dulce (Sweet Bread)	337	463.90	431.50	-32.40	6.98	9.84	10.34	+0.50	5.08	1.37	1.29	-0.08	5.84
7. Tortilla (Corn)	338	452.14	440.63	-11.51	2.55	2.52	2.35	-0.17	6.75	1.74	1.66	-0.08	4.60
8. Stools	Bal.48(1)-E330	491.08	478.12	-12.96	2.64	15.47	15.04	-0.43	2.78	6.30	6.07	-0.23	3.65
9. Stools	Bal.48(11)E330	495.18	464.62	-30.56	6.17	10.57	10.14	-0.43	4.07	7.43	7.26	-0.17	2.29
10. Stools	Bal.48(1)-E332	493.90	481.15	-12.75	2.58	11.14	10.86	-0.28	2.51	7.07	6.69	-0.38	5.37
11. Stools	Bal.48(11)E332	475.15	479.13	+3.98	0.84	8.96	8.74	-0.22	2.46	7.27	7.21	-0.06	0.83
12. Stools	Bal.48(1)-E336	469.49	439.31	-30.18	6.43	13.71	13.43	-0.28	2.04	6.94	6.37	-0.57	8.21
13. Stools	Bal.48(11)E336	489.81	454.80	-35.01	7.15	9.74	9.25	-0.49	5.03	7.85	7.28	-0.57	7.26
14. Stools	Bal.45(1)-E310	499.22	473.18	-26.04	5.22	11.49	10.94	-0.55	4.79	6.90	6.26	-0.64	9.28
15. Stools	Bal.45(11)E310	497.53	457.37	-40.16	8.07	10.20	9.80	-0.49	4.76	7.09	6.38	-0.71	10.01
16. Stools	Bal.50(1)-E345	503.68	486.45	-22.23	4.37	9.97	9.24	-0.73	7.32	7.06	9.97	+2.91	41.22
17. Stools	Bal.50(11)E345	504.15	501.63	-2.52	0.50	9.16	8.86	-0.30	3.28	7.86	7.39	-0.47	5.98
18. Stools	Bal.52(1)-E360	511.89	490.00	-21.89	4.[illegible]	11.15	10.92	-0.23	2.06	6.86	7.31	+0.45	6.56
19. Stools	Bal.52(11)E360	504.15	-	-	-	10.40	-	-	-	7.30	6.42	-0.88	12.05
Mean		493.38	469.45	22.21		8.96	8.63	0.33		6.36	6.21	0.51	
Std. Error		6.59	5.29	3.01		0.83	0.84	0.07		0.71	0.72	0.15	
t				6.73				3.526				1.213	
Significance				p<.01				p<.01				N.S.	

TABLE IX.3

1976 Quality Control On Analyses Of Metabolic Ward Samples

Food Item	INCAP Identification Number	Calories (Kcal/100 g - Dry weight)				Fat (g/100 g - Dry weight)				Nitrogen (g/100 g - Dry weight)			
		UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.
1. Tortilla	094	448.04	463.00	+14.96	3.34	3.16	3.02	-0.14	4.43	1.55	1.49	-0.06	3.87
2. Egg Protein Formula I	1350	464.23	456.21	-8.02	1.73	8.53	7.96	-0.62	7.28	0.93	0.91	-0.02	2.15
3. Egg Protein Formula II	1110	526.77	510.34	-16.43	3.12	0.51	0.54	+0.03	5.88	13.37	12.00	-1.37	10.25
4. Rice	085	424.55	405.73	-18.82	4.43	0.65	0.70	+0.05	7.69	1.52	1.47	-0.05	3.29
5. Beans (Black)	1117	439.06	441.30	+2.24	0.51	2.17	2.00	-0.17	7.83	4.13	3.83	-0.30	7.26
6. Stools	Bal. 64-1 E - 435	512.49	492.60	-19.89	3.88	7.33	6.70	-0.63	8.59	6.74	6.00	-0.74	10.98
7. Stools	Bal. 3[illegible] - 1[illegible] E - 417	543.18	520.63	-22.55	4.15	9.71	8.90	-0.81	8.34	6.82	6.43	-0.39	5.72
8. Stools	Bal. 53 - 1 E - 433	516.82	501.30	-15.52	3.00	7.74	7.15	-0.59	7.62	7.32	6.64	-0.68	9.29
9. Stools	Bal. 63 - 11 E - -33	544.87	551.82	+6.95	1.28	9.70	9.73	+0.03	0.31	6.66	6.54	-0.12	1.80
10. Stools	Bal. 6[illegible] - 1 E - 479	503.15	470.30	-33.45	6.64	7.92	7.18	-0.74	9.34	6.81	6.43	-0.33	5.58

See TABLE IX.4 for summary of 1976 samples.

TABLE IX.4

1976 Quality Control On Analyses Of Metabolic Ward Samples (cont'd)

Food Item	INCAP Identification Number	Calories (Kcal/100 g - Dry weight)				Fat (g/100 g - Dry weight)				Nitrogen (g/100 g - Dry weight)			
		UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.	UNC	INCAP	Diff.	% Diff.
11. Beans (Black)	432	451.86	416.30	-35.56	7.87	1.79	1.57	-0.22	12.29	4.36	4.10	-0.26	5.96
12. Egg	482	693.55	657.00	-36.55	5.27	35.80	37.80	+2.00	5.59	8.19	7.85	-0.34	4.15
13. Tortilla	472	459.14	438.00	-21.14	4.60	2.88	2.20	-0.68	23.61	1.56	1.47	-0.09	5.77
14. Rice	502	451.23	438.60	-12.63	2.80	3.56	2.60	-0.96	26.97	1.26	1.24	-0.02	1.59
15. Pan Dulce (Sweet Bread)	484	440.80	423.70	-17.10	3.88	4.37	5.18	+0.81	18.54	1.51	1.51	0.00	-
16. Stools	Bal. 58 - I E - 373	491.32	472.40	-18.92	3.85	6.25	6.62	+0.37	5.92	6.93	6.45	-0.48	6.93
17. Stools	Bal. 58 -II E - 375	493.57	466.20	-27.37	5.55	6.60	5.72	-0.88	13.33	7.09	6.81	-0.28	3.95
18. Stools	Bal. 58 -II E - 374	511.78	509.12	-2.66	0.52	9.78	8.67	-1.11	11.35	7.21	7.00	-0.21	2.91
19. Stools	Bal. 58 - I E - 376	497.20	477.00	-20.20	4.06	10.81	11.15	+0.34	3.15	5.62	5.19	-0.43	7.65
20. Stools	Bal. 58 - I E - 370	508.46	496.80	-11.66	2.29	9.63	7.16	-2.47	25.65	6.51	6.14	-0.37	5.68
Mean		496.13	480.41	18.13		7.45	7.13	0.68		5.30	4.98	0.33	
Std. Error		13.53	12.83	3.17		1.75	1.85	0.20		0.72	0.66	0.07	
t				4.93				1.91				4.74	
Significance				p<.01				N.S.				p<.01	

TABLE IX.5

Analysis Of National Academy of Sciences Cottonseed Meal

Origin	Dry Matter g/100 g	Calories* small cal/gm	Fat g/100 g (dry weight)	Nitrogen* g/100 g (dry weight)	Protein* g/100 g calculated (x 6.25)
NAS #11208EB	89.95	4250.0	not available	8.55	53.44
UNC	93.31	4433.7	3.55	7.98	49.87
Guatemala	93.95	4134.3	3.60	7.68	48.00
NAS #12340	-	-	-	9.72*	-
UNC	-	-	-	9.63	-
Guatemala	-	-	-	9.58	-

*Average of three determinations

10) and Saunders (11). An alternative method, which was not used, is that employing ether extraction. This latter method is not practical for the large numbers of determinations which were necessary in this project. In addition, the ether extraction method also dissolves ether-soluble but non-fat materials.

(3). Nitrogen. The determination of nitrogen was done in both laboratories by the well-known Kjeldal procedure (12) as modified by the procedure of the Association of Official Agricultural Chemists (13).

3. Results and Recommendations

a. Calories. 1974 metabolic results (see tables IX.1, IX.2, IX.3 and IX.4) based on quality control samples, are well within a biologically acceptable 10 percent (0.72% - 6.50%). There is a small, but distinct, tendancy for the INCAP energy values to be slightly lower (except for #8) but still within an acceptable 10 percent. It is possible that the use of two bomb calorimeters (UNC's Parr Bomb and INCAP's Gallenkamp) may have been the cause of this difference. As in the 1974 series, all caloric determinations in the 1975 balance studies are well within 10 percent (0.50% - 8.0%). Again, the caloric values obtained are lower than the UNC reference values but still within an acceptable 10 percent. All values in the 1976 Metabolic Balance Studies (1st balance IIIA and 2nd balance IIIB combined) are also within an acceptable 10 percent. As was true of the 1974 and 1975 results, the caloric values are slightly lower than the UNC reference determinations (0.51% - 6.64%). On the basis of these quality control determinations, there does not appear to be any reason why the caloric values should not be used to assess malabsorption and food waste costs.

b. Fat. The agreement between UNC's quality control analyses and those completed at INCAP for the 1974 balances are very poor. This is apparent

from an examination of the numerical and percent differences in the "Fat" column of Table IX.1. In the 1975 results, there was better agreement between INCAP and UNC values. All values except #335 (Table IX.2) are within the biologically accepted 10 percent range. Although the values for fat in Table IX.3 (1976 balance) are much better than those in Table IX.4, the large differences make it doubtful if they should be used to estimate fat absorption or malabsorption till further quality control checks are done.

Because of the wide disparity in results between the UNC external reference values and the INCAP values for fat, the use of these values for acertaining malabsorption must be done with caution. Fat determinations were a continuing problem which has been discussed in several previous reports.

c. Nitrogen. In the 1974 balance, with the exception of #305 (17.16% difference) and #310 (15.25% difference), the values are within an acceptable 10 percent error. Except for samples 335, E345(1) and E360(II) in the 1975 balance, and #1110 and #E435 in the 1976 combined balances, all values are within the 10 percent range.

4. Analysis of National Academy of Sciences Cottonseed Meal

To assess the analytical values obtained by both UNC and INCAP for calories, fat and nitrogen, a sample of cottonseed meal of known chemical composition (2) was analyzed by both laboratories. These values are presented in Table IX.5. There was a close correspondence between the results from the two laboratories.

APPENDIX

Chapter II

Village Comparisons

APPENDIX

Chapter II

Village Comparisons

Distribution of Persons Present Over Time
(March 1973 - September 1976)

Year-Month	Guanagazapa	Florida Aceituno
7303	906	764
7304	903	821
7305	1019	863
7306	1034	867
7307	1030	861
7308	1036	902
7309	1036	868
7310	1036	865
7311	988	865
7312	988	856
7401	1009	856
7402	1009	857
7403	1079	856
7404	1079	861
7405	1076	908
7406	1075	907
7407	1074	904
7408	1096	903
7409	1109	896
7410	1082	921
7411	1048	921
7412	1048	959
7501	1077	984
7502	1113	991
7503	1098	986
7504	1111	970
7505	1111	982
7506	1112	1005
7507	1116	1020
7508	1163	1005
7509	1170	1009
7510	1151	981
7511	1157	981
7512	1157	972
7601	1160	972
7602	1160	1021
7603	1171	1021
7604	1171	1046
7605	1193	1034
7606	1194	1044
7607	1192	1077
7608	1192	1083
7609	1188	1083

Distribution of Persons Present Over Time by Sex
(March 1973 - September 1976)

Year-Month	Guanagazapa Male	Guanagazapa Female	Florida Aceituno Male	Florida Aceituno Female
7303	460	426	417	347
7304	520	473	445	376
7305	530	489	469	394
7306	544	490	472	395
7307	541	489	468	393
7308	541	495	481	421
7309	543	493	470	398
7310	543	493	470	398
7311	527	461	475	390
7312	527	461	475	390
7401	533	476	473	383
7402	533	476	473	383
7403	563	516	475	382
7404	563	516	475	381
7405	566	510	474	387
7406	564	511	497	411
7407	563	511	499	408
7408	573	523	498	406
7409	578	531	494	409
7410	563	519	492	404
7411	543	505	502	419
7412	543	505	502	419
7501	562	515	524	435
7502	581	532	531	453
7503	577	521	528	463
7504	580	531	532	454
7505	590	521	528	442
7506	588	524	531	451
7507	588	528	545	460
7508	616	547	554	466
7509	618	552	544	461
7510	614	537	541	468

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Births, Deaths and Migration by Sex
(April 1973 - September 1976)

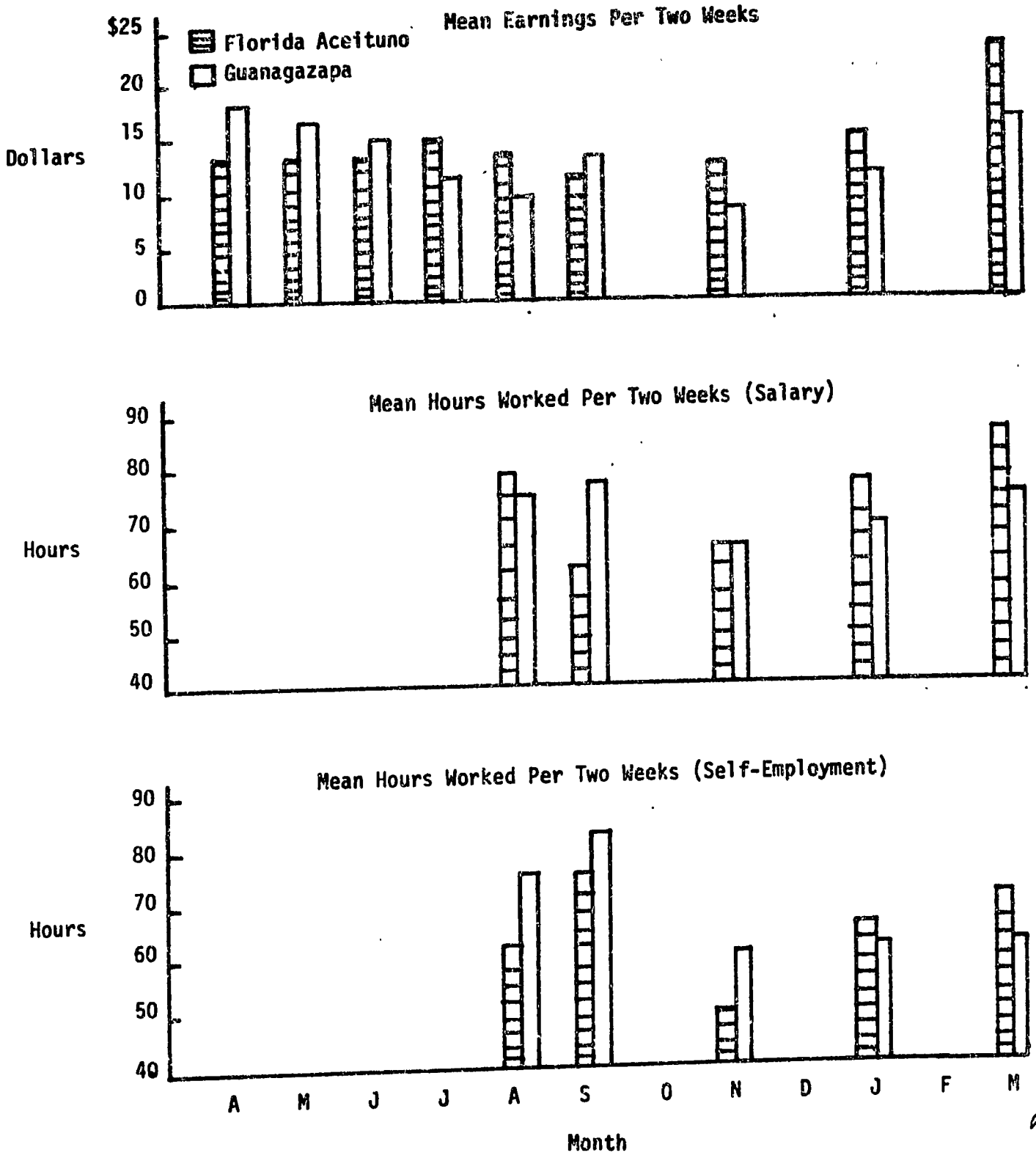
Population Dynamic	Guanagazapa	Florida Aceituno
Entering village*	1837	1887
Male	914	961
Female	923	926
Leaving village*	1555	1568
Male	770	796
Female	785	772
Population increase	282	319
Population increase(%)	31	42

*Entering: births, immigration
Leaving: deaths, outmigration

Note: This data is based on the monthly census completed in each village. An individual is counted as either entering or leaving the village if they were present or absent in the previous month. It is possible that only a small proportion of the total population in either village was responsible for most of the migration, i.e., they moved in and out frequently during the study period.

Village Economics

Comparison of Employment and Earnings
(April 1973 - March 1974)



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Village Economics
Reasons For No Economic Activity
(Heads of Household)

Month	August 1973		November 1973		January 1974		March 1974	
Number of Subjects	GU 55	FA 64	GU 62	FA 51	GU 58	FA 64	GU 58	FA 63
Reason	····· Days Absent (Percentage) For Each Group of Subjects ·····							
Illness Hospital	12(21)	12(30)	18(28)	13(23)	20(35)	14(37)	14(25)	42(84)
Family Social Holiday Affairs	-	3(8)	10(16)	1(2)	9(16)	6(16)	15(27)	-
Could Not Find Work	4(7)	9(22)	27(42)	3(5)	28(49)	10(26)	23(42)	-
Resting	31(54)	16(40)	9(14)	39(70)	-	8(21)	3(6)	8(16)
Other	10(18)	-	-	-	-	-	-	-
Total Days Not Worked	57(100)	40(100)	64(100)	56(100)	57(100)	38(100)	55(100)	50(100)

APPENDIX

Chapter III

Morbidity

Diarrheal Morbidity Rate Descriptive Statistics
by Quarter and Village

VILL=FA

VARIABLE	LABEL	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
UNIQFAM	4-DIGIT UNIQUE FAMILY ID	358	1195.751397	113.8538657	1001.000000	1384.00000	6.01736378
NORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY	358	4.625698	3.0723505	1.000000	21.00000	0.16237877
DIARGR01	QUARTERLY DIARRHEAL RATES, QUARTER 1	209	96.650366	121.2867317	0.000000	600.00000	8.38971700
DIARGR02	QUARTER 2	212	67.645821	111.3314904	0.000000	555.55556	7.64627870
DIARGR03	QUARTER 3	212	41.923011	80.0872259	0.000000	400.00000	5.50041326
DIARGR04	QUARTER 4	198	56.456429	97.3402642	0.000000	625.00000	6.91767135
DIARGR05	QUARTER 5	219	50.024931	83.5813419	0.000000	666.66667	5.64790368
DIARGR06	QUARTER 6	231	26.138942	59.3992327	0.000000	500.00000	3.90918258
DIARGR07	QUARTER 7	231	26.489119	61.3226400	0.000000	333.33333	4.03473249
DIARGR08	QUARTER 8	242	48.277206	97.7018597	0.000000	666.66667	6.28565601
DIARGR09	QUARTER 9	252	43.756914	87.6169806	0.000000	666.66667	5.51935099
DIARGR10	QUARTER 10	242	32.506638	93.2883773	0.000000	1000.00000	5.99680401
DIARGR11	QUARTER 11	236	29.435359	71.5929763	0.000000	400.00000	4.66030581
DIARGR12	QUARTER 12	243	38.102913	66.6807705	0.000000	333.33333	4.27757342
DIARGR13	QUARTER 13	266	42.703901	76.5982162	0.000000	375.00000	4.69653797
DIARGR14	QUARTER 14	259	34.124059	105.9937686	0.000000	1000.00000	6.58613252

VILL=GU

VARIABLE	LABEL	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
UNIQFAM	4-DIGIT UNIQUE FAMILY ID	315	2170.172956	95.9510175	2001.000000	2332.00000	5.39066587
NORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY	318	4.927673	3.4446211	1.000000	27.00000	0.19316476
DIARGR01	QUARTERLY DIARRHEAL RATES, QUARTER 1	212	85.665658	118.2904588	0.000000	500.00000	7.84950094
DIARGR02	QUARTER 2	213	49.246650	101.1579755	0.000000	500.00000	6.93123027
DIARGR03	QUARTER 3	214	20.421729	57.0772136	0.000000	400.00000	3.90171800
DIARGR04	QUARTER 4	214	52.530667	100.0214937	0.000000	500.00000	6.83732055
DIARGR05	QUARTER 5	222	45.500751	80.7901651	0.000000	500.00000	5.42228095
DIARGR06	QUARTER 6	221	19.407959	44.5230509	0.000000	333.33333	2.99444451
DIARGR07	QUARTER 7	222	19.756039	56.2502511	0.000000	400.00000	3.77526967
DIARGR08	QUARTER 8	231	27.900092	59.9923747	0.000000	333.33333	3.94720846
DIARGR09	QUARTER 9	234	28.935406	58.3824359	0.000000	375.00000	3.81664460
DIARGR10	QUARTER 10	239	24.404455	56.5431265	0.000000	333.33333	3.65747080
DIARGR11	QUARTER 11	245	16.643587	48.5405621	0.000000	250.00000	3.10165386
DIARGR12	QUARTER 12	248	28.707812	61.0470682	0.000000	500.00000	3.87649271
DIARGR13	QUARTER 13	253	39.907800	68.9219329	0.000000	388.88889	4.33308480
DIARGR14	QUARTER 14	242	17.297980	87.1745156	0.000000	1000.00000	5.60379010

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Diarrheal Morbidity by Season, Sex and Village

Rate/1000 Population

SEASON	FEMALE			MALE			BOTH		
	FA	GU	BOTH	FA	GU	BOTH	FA	GU	BOTH
1	112.1 7.06 1999	86.8 5.60 2454	98.1 4.46 4453	86.9 5.00 2358	78.2 5.27 2597	82.5 3.91 4955	98.5 4.51 4357	82.9 3.87 5051	89.8 2.95 9408
2	65.7 6.42 1491	42.4 4.64 1087	52.7 3.84 3378	53.7 5.36 1768	36.8 4.44 1794	45.2 3.48 3562	59.2 4.13 3259	39.7 3.22 3581	48.8 2.59 6940
3	45.7 4.26 2407	36.9 3.39 3093	40.7 2.67 5500	36.1 3.48 2881	29.7 3.05 3095	32.8 2.30 5976	40.5 2.71 5288	33.3 2.28 6188	36.6 1.75 11476
4	38.4 4.08 2214	25.1 3.07 2591	31.2 2.51 4805	40.3 3.87 2579	21.4 2.83 2612	30.8 2.40 5191	39.4 2.81 4793	23.3 2.09 5203	31.0 1.73 9996
5	39.0 3.69 2746	30.2 3.03 3184	34.2 2.36 5930	37.6 3.35 3218	26.5 2.74 3440	31.8 2.15 6658	38.2 2.48 5964	28.2 2.04 6624	33.0 1.59 12588
6	47.0 4.42 2296	31.3 3.34 2719	38.5 2.72 5015	35.1 3.57 2652	24.4 2.40 2830	29.6 2.29 5482	40.6 2.81 4948	27.8 2.21 5549	33.8 1.76 10497
7	49.0 4.95 1899	45.1 4.41 2217	46.9 3.30 4116	45.5 4.44 2198	34.2 3.72 2395	39.6 2.80 4593	47.1 3.31 4097	39.5 2.67 4612	43.1 2.13 8709
TOTAL	54.8 1.86 15052	41.5 1.48 18145	47.5 1.17 33197	46.6 1.59 17654	35.1 1.34 18763	40.7 1.04 36417	50.4 1.21 32796	38.3 1.00 36908	43.9 0.78 69614

Key: Rate/1000
Standard error
Number of persons
Time-May 1973 to October 1976

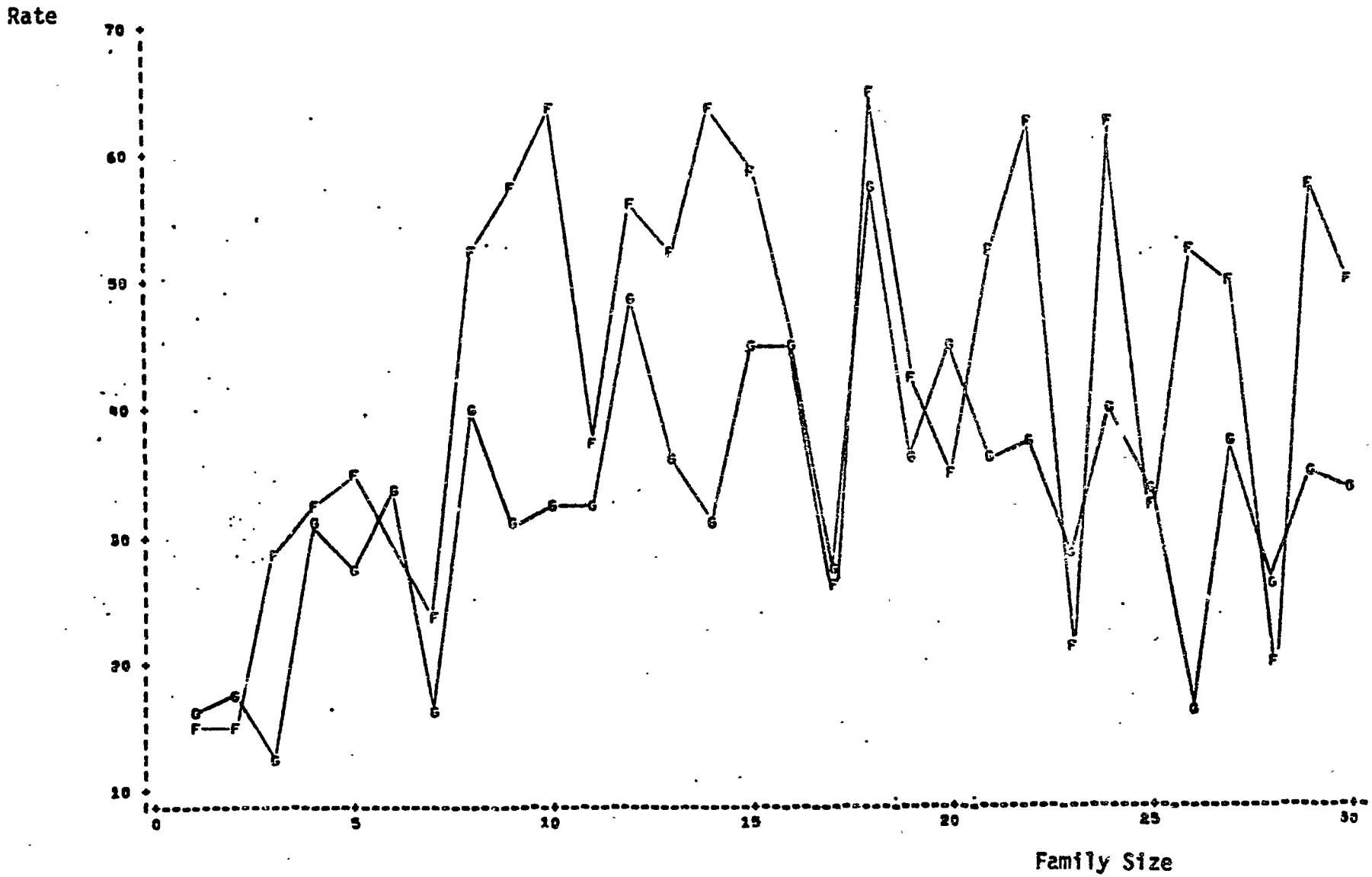
Diarrheal Morbidity by Age, Sex and Village
Rate/1000 Population

AGE CATEGORY	FEMALE FA	FEMALE GU	FEMALE BOTH	MALE FA	MALE GU	MALE BOTH	BOTH FA	BOTH GU	BOTH BOTH
AGE00-01	96.0 81 844	99.5 76 764	97.6 157 1608	122.4 105 858	140.9 92 653	130.4 197 1511	109.3 186 1702	118.6 168 1417	113.5 354 3119
AGE01-02	225.4 151 670	208.8 162 776	216.5 313 1446	218.3 143 655	204.8 128 625	211.7 271 1280	221.9 294 1325	207.0 290 1401	214.2 584 2726
AGE02-07	98.9 259 2619	74.3 231 3107	85.6 490 5726	121.0 317 2620	69.9 230 3290	92.6 547 5910	109.9 576 5239	72.1 461 6397	89.1 1037 11636
AGE07-15	40.5 103 2546	26.3 116 4405	31.5 219 6951	35.6 115 3230	17.8 73 4107	25.4 186 7337	37.4 216 5776	22.2 189 8512	28.3 405 14288
AGE15-30	22.6 91 4022	13.4 56 4178	17.9 147 8200	11.3 50 4435	9.5 47 4956	10.3 97 9392	16.7 141 8458	11.3 103 9134	13.9 244 17592
AGE30-45	30.0 62 2068	12.8 32 24[illegible]	20.6 94 4561	14.0 41 2928	15.1 36 2389	14.5 77 5317	20.6 103 4996	13.9 68 4882	17.3 171 9878
AGE45-99	34.2 78 2283	33.0 80 2422	33.6 158 4705	18.1 53 2927	19.3 53 2743	18.7 106 5670	25.1 131 5210	23.8 133 5165	25.4 264 10375
TOTAL	54.8 825 15052	41.5 753 18145	47.5 1578 33197	46.6 822 17654	35.2 661 18798	40.7 1483 [illegible]452	50.4 1647 32706	38.3 1414 36943	43.9 3061 69649

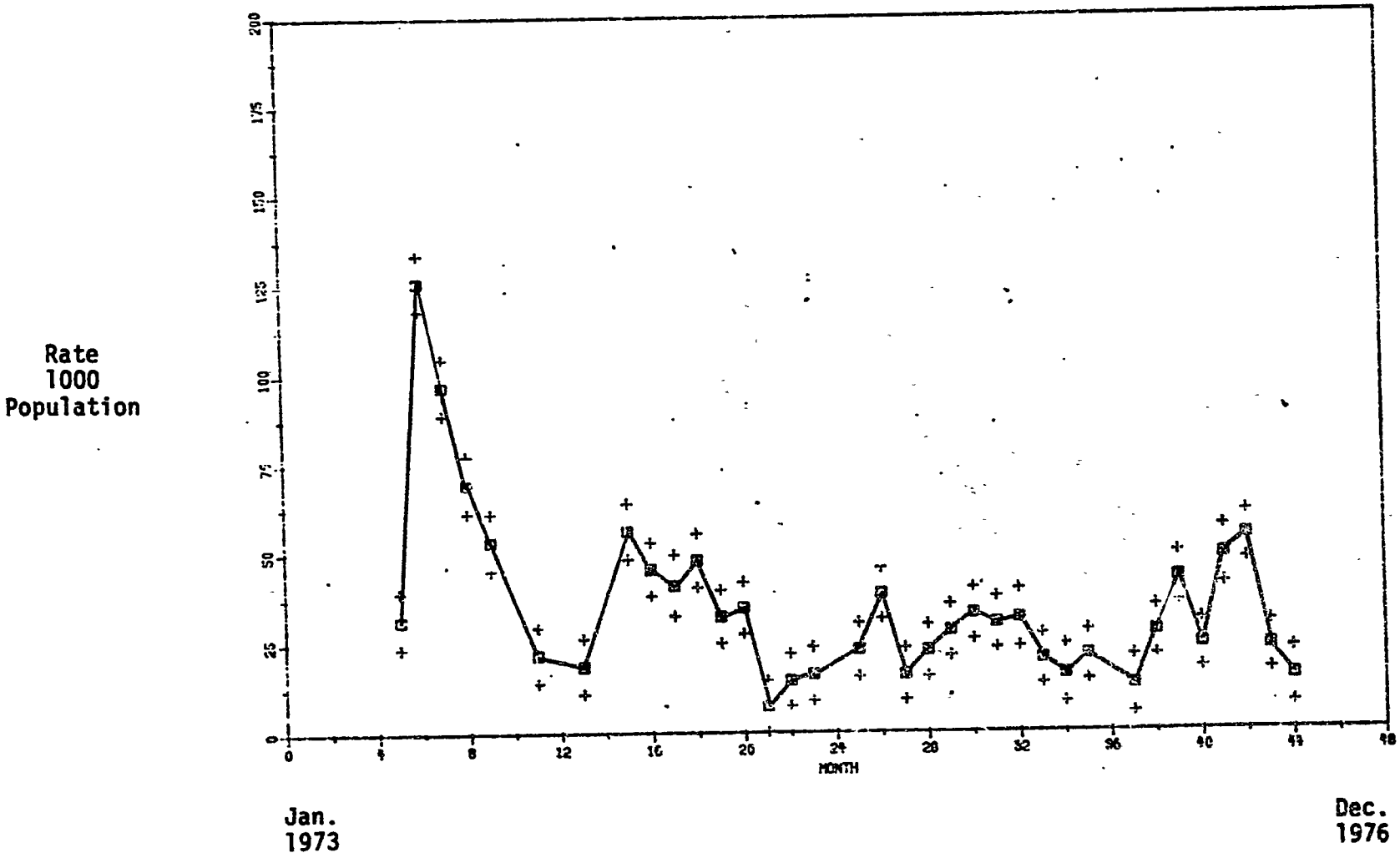
Key: Rate/1000
Numerator-cases
Denominator-population at risk

Mean Quarterly Diarrhea Rate Versus Family Size by Village

Rate/1000

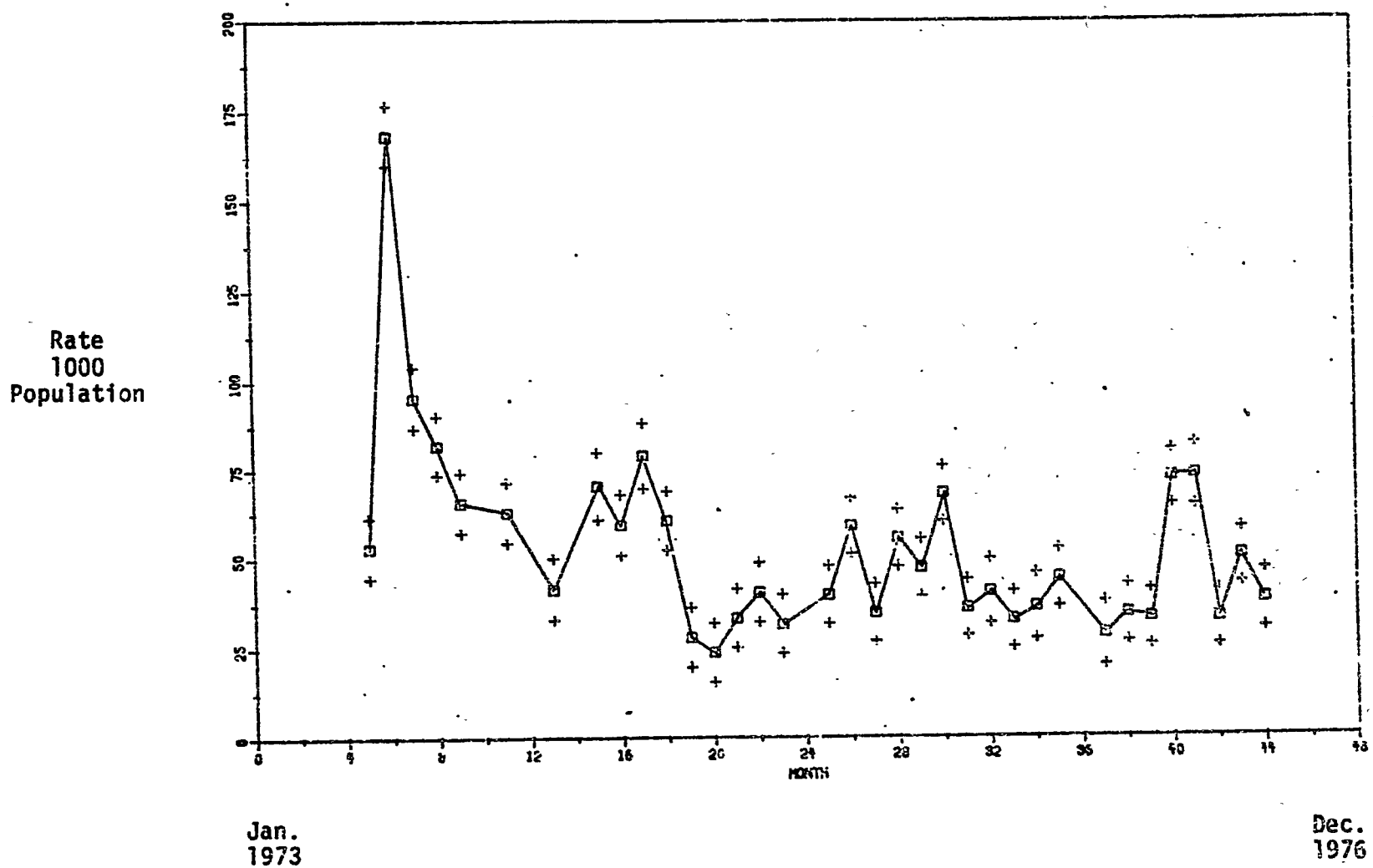


Adjusted Diarrheal Rate for Guanagazapa*
(mean and standard deviation)



*Estimate of morbidity rate adjusted for families with five or more persons and the geometric mean of their water consumption.

Adjusted Diarrheal Rate in Florida Aceituno*
(mean and standard deviation)



*Estimate of morbidity rate for families with five or more persons.

Infectious Diseases Morbidity Rate Descriptive Statistics
by Quarter and Village

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
UNIQFAM	4-DIGIT UNIQUE FAMILY ID		358	1195.751397	113.8538657	1001.000000	1385.00000	6.01756378
MORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY		358	4.625698	3.0723505	1.000000	21.00000	0.16237877
INFCOR01	QUARTERLY INFECTIOUS DISEASE RATES,	QUARTER 1	209	33.352716	63.8485274	0.000000	333.33333	4.41649459
INFCOR02		QUARTER 2	212	8.771339	36.1857471	0.000000	250.00000	2.48524732
INFCOR03		QUARTER 3	212	4.463520	37.0566421	0.000000	500.00000	2.54506063
INFCOR04		QUARTER 4	198	8.619929	35.0601267	0.000000	250.00000	2.49161471
INFCOR05		QUARTER 5	219	22.427041	44.5829309	0.000000	400.00000	3.01243523
INFCOR06		QUARTER 6	231	10.013709	35.5503539	0.000000	266.66667	2.33904136
INFCOR07		QUARTER 7	231	13.458267	59.5695597	0.000000	500.00000	3.65620860
INFCOR08		QUARTER 8	242	14.723902	50.9105467	0.000000	500.00000	3.27265389
INFCOR09		QUARTER 9	242	44.591640	89.3512385	0.000000	500.00000	5.37662265
INFCOR10		QUARTER 10	242	15.050345	50.8817186	0.000000	500.00000	3.27080075
INFCOR11		QUARTER 11	236	9.866361	36.0151661	0.000000	222.22222	2.34438762
INFCOR12		QUARTER 12	243	9.220311	29.8340470	0.000000	190.47619	1.91385501
INFCOR13		QUARTER 13	266	13.681611	46.5156914	0.000000	500.00000	2.85207229
INFCOR14		QUARTER 14	259	6.531532	46.8939759	0.000000	500.00000	2.91334988
----------	----------	----------	VILLEGU	----------	----------	----------	----------	----------
UNIQFAM	4-DIGIT UNIQUE FAMILY ID		318	2170.172956	95.9510175	2001.000000	2532.00000	5.38066587
MORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY		318	4.927673	3.4446211	1.000000	27.00000	0.19316476
INFCOR01	QUARTERLY INFECTIOUS DISEASE RATES,	QUARTER 1	232	2.435566	14.6910552	0.000000	142.85714	1.00904076
INFCOR02		QUARTER 2	213	3.067479	17.0901861	0.000000	125.00000	1.17099478
INFCOR03		QUARTER 3	215	0.784262	8.1217260	0.000000	98.90909	0.55518976
INFCOR04		QUARTER 4	214	6.862569	41.4079590	0.000000	500.00000	2.83058980
INFCOR05		QUARTER 5	222	9.813898	49.4554465	0.000000	500.00000	3.31923224
INFCOR06		QUARTER 6	221	20.250981	57.2883511	0.000000	307.69231	3.85363152
INFCOR07		QUARTER 7	222	4.374098	36.0301774	0.000000	500.00000	2.41818717
INFCOR08		QUARTER 8	231	14.934983	51.9442147	0.000000	400.00000	3.41767641
INFCOR09		QUARTER 9	234	58.612862	104.2808760	0.000000	873.68421	6.81705412
INFCOR10		QUARTER 10	239	6.194181	25.6108332	0.000000	166.66667	1.65662709
INFCOR11		QUARTER 11	245	2.589791	19.3572213	0.000000	250.00000	1.23668751
INFCOR12		QUARTER 12	248	0.212224	3.3421086	0.000000	52.63158	0.21222411
INFCOR13		QUARTER 13	253	3.342069	16.5757657	0.000000	166.66667	1.04210946
INFCOR14		QUARTER 14	242	3.261259	25.9933958	0.000000	833.33333	1.67091877

Infectious diseases: otitis and conjunctivitis

Infectious Diseases Morbidity by Season, Sex and Village

Rate/1000 Population

SEASON	FEMALE			MALE			BOTH		
	FA	GU	BOTH	FA	GU	BOTH	FA	GU	BOTH
1	31.5 3.91 1995	3.3 1.15 2454	15.9 1.88 4453	22.1 3.02 2358	2.7 1.02 2597	11.9 1.54 4955	26.4 2.43 4357	3.0 0.77 5051	13.8 1.20 9408
2	9.4 2.50 1491	3.7 1.40 1887	6.2 1.35 3378	6.2 1.87 1768	3.3 1.36 1794	4.8 1.15 3562	7.7 1.53 3259	3.5 0.98 3681	5.5 0.89 6940
3	12.0 2.22 2407	16.8 2.31 3093	14.7 1.62 5500	11.8 2.01 2081	16.5 2.29 3095	14.2 1.53 5976	11.9 1.49 5288	16.6 1.63 6188	14.5 1.11 11476
4	12.2 2.33 2214	10.4 1.99 2591	11.2 1.52 4805	14.3 2.34 2579	9.6 1.91 2612	11.9 1.51 5191	13.4 1.66 4793	10.0 1.38 5203	11.6 1.07 9996
5	39.0 3.69 2746	37.1 3.35 3184	37.9 2.48 5930	26.7 2.84 3218	37.2 3.23 3440	32.1 2.16 6658	32.4 2.29 5964	37.1 2.32 6624	34.9 1.64 12588
6	11.3 2.21 2296	1.1 0.64 2719	5.8 1.07 5015	12.4 2.15 2652	2.1 0.86 2830	7.1 1.14 5482	11.9 1.54 4948	1.6 0.54 5549	6.5 0.78 10497
7	11.6 2.46 1899	4.1 1.35 2217	7.5 1.35 4116	14.1 2.52 2198	4.6 1.38 2395	9.1 1.40 4593	12.9 1.77 4097	4.3 0.97 4612	8.4 0.98 8709
TOTAL	19.1 1.12 15052	12.3 0.82 18145	15.4 0.68 33197	16.1 0.95 17654	12.5 0.81 18763	14.2 0.62 36417	17.5 0.72 32706	12.4 0.58 36908	14.8 0.46 69614

Key: Infectious diseases: otitis, conjunctivitis
Rate/1000
Number of persons
Time: May 1973 to October 1976

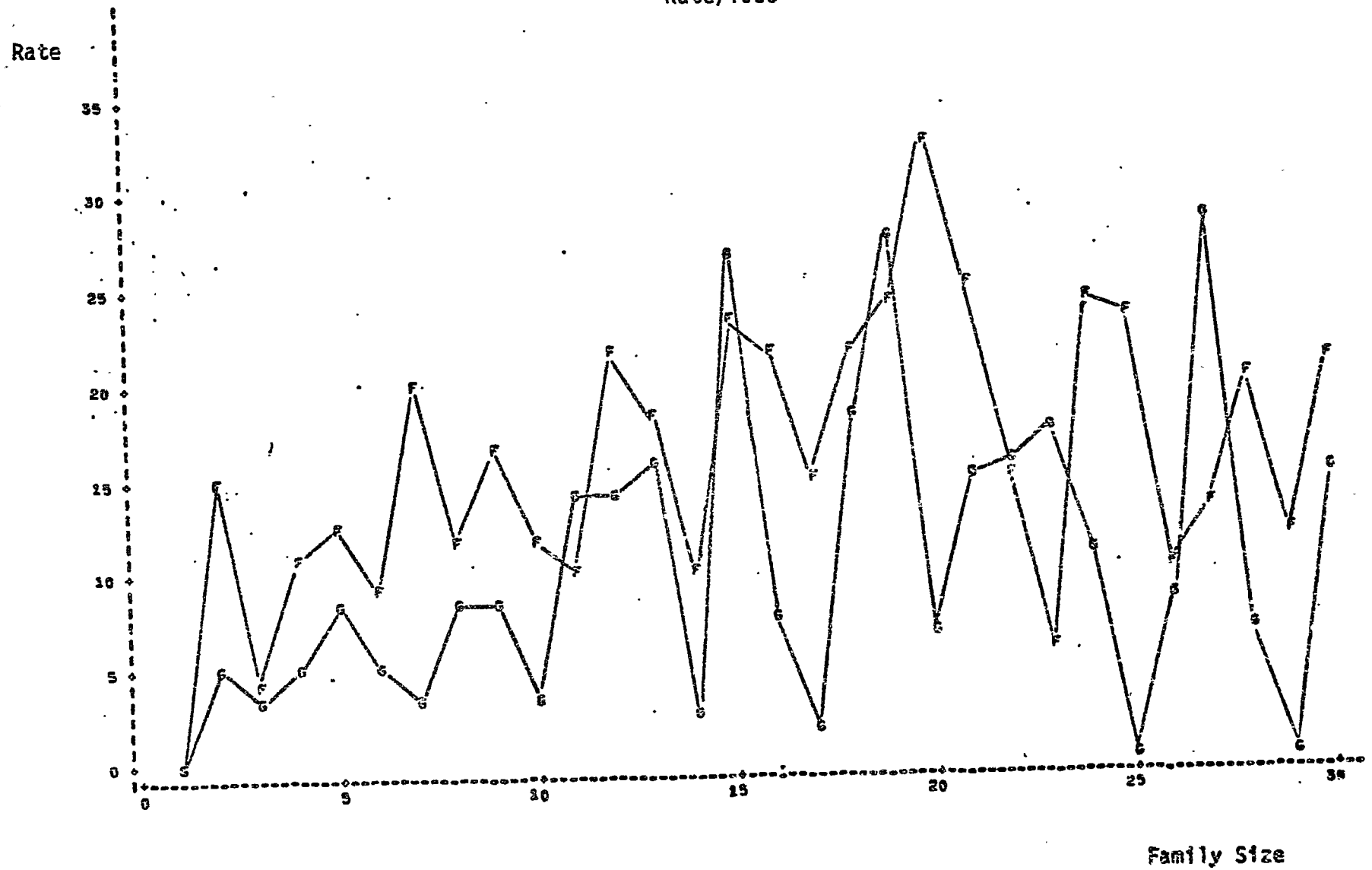
Infectious Diseases Morbidity by Age, Sex and Village
Rate/1000 Population

AGE CATEGORY	FEMALE FA	FEMALE GU	FEMALE BOTH	MALE FA	MALE GU	MALE BOTH	BOTH FA	BOTH GU	BOTH BOTH
AGE00-01	61.6 52 844	43.2 33 764	52.9 85 1608	45.5 39 858	38.3 25 653	42.4 64 1511	53.5 91 1702	40.9 58 1417	47.8 149 3119
AGE01-02	83.6 56 670	33.5 26 776	56.7 82 1446	68.7 45 655	51.2 32 625	60.2 77 1280	76.2 101 1325	41.4 58 1401	58.3 159 2726
AGE02-07	32.1 84 2619	28.6 89 3107	30.2 173 5726	48.5 127 2620	33.7 111 3250	40.3 238 5910	40.3 211 5239	31.3 200 6397	35.3 411 11636
AGE07-15	12.6 32 2546	8.2 36 4405	9.8 68 6951	10.5 34 3230	9.0 37 4107	9.7 71 7337	11.4 66 5776	8.6 73 8512	9.7 139 14288
AGE15-30	7.5 30 4022	4.1 17 4178	5.7 47 8200	2.0 9 4436	3.0 15 4956	2.6 24 9392	4.6 39 8458	3.5 32 9134	4.0 71 17592
AGE30-45	5.8 12 2068	6.8 17 2493	6.4 29 4561	4.1 12 2928	3.8 9 2389	3.9 21 5317	4.8 24 4996	5.3 26 4882	5.1 50 9878
AGE45-99	9.6 22 2283	2.5 6 2422	6.0 28 4705	6.1 18 2927	1.8 5 2743	4.1 23 5670	7.7 40 5210	2.1 11 5165	4.9 51 10375
TOTAL	19.1 288 15052	12.3 224 18145	15.4 512 33197	16.1 284 17654	12.4 234 18798	14.2 518 36452	17.5 572 32706	12.4 458 36943	14.8 1030 69649

Key: Infectious diseases: otitis, conjunctivitis
Rate/1000
Numerator: cases
Denominator: population at risk

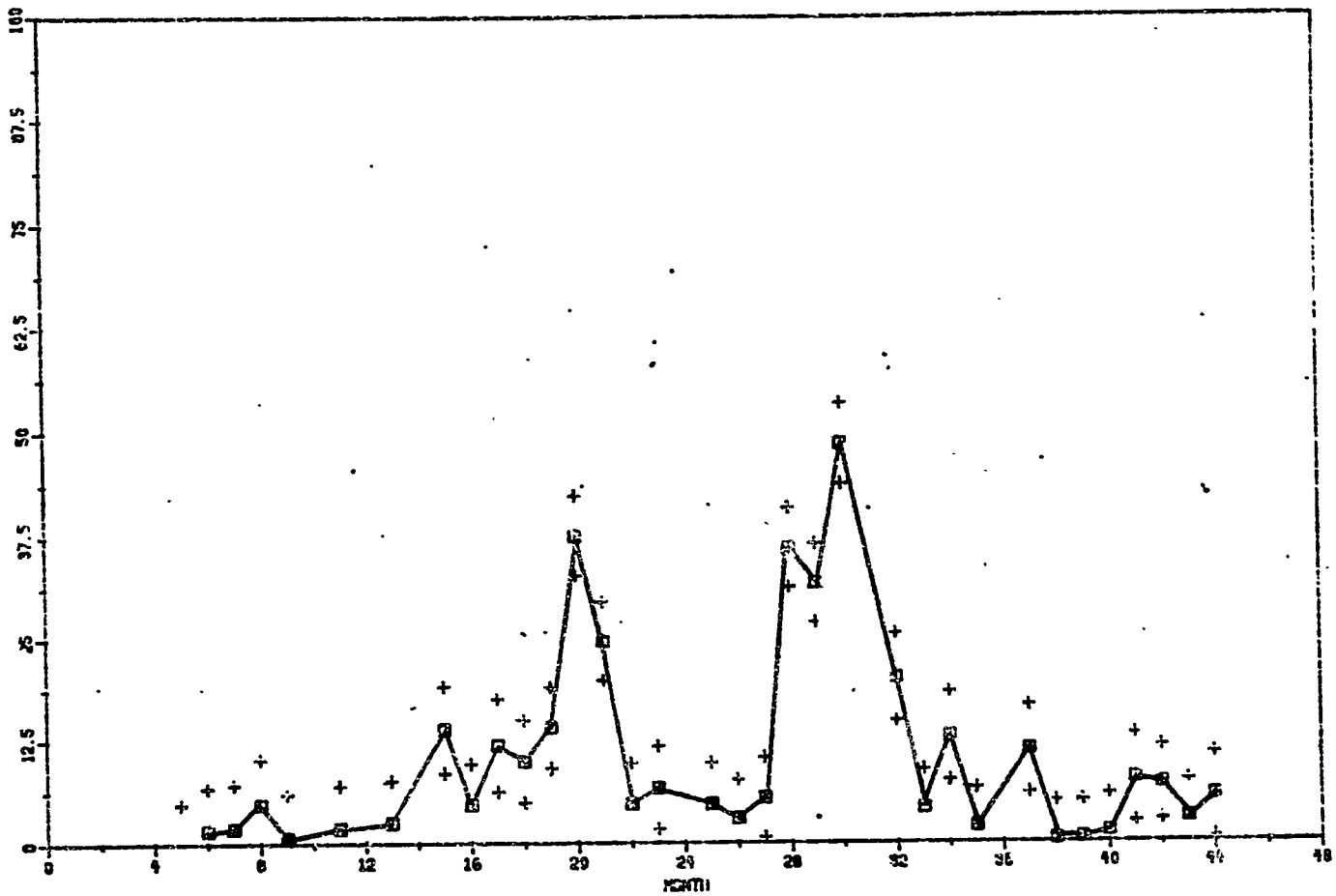
Mean Quarterly Infectious Diseases Rate Versus Family Size by Village

Rate/1000



Adjusted Infectious Disease Rate in Guanagazapa
(mean and standard deviation)

Rate
1000
Population



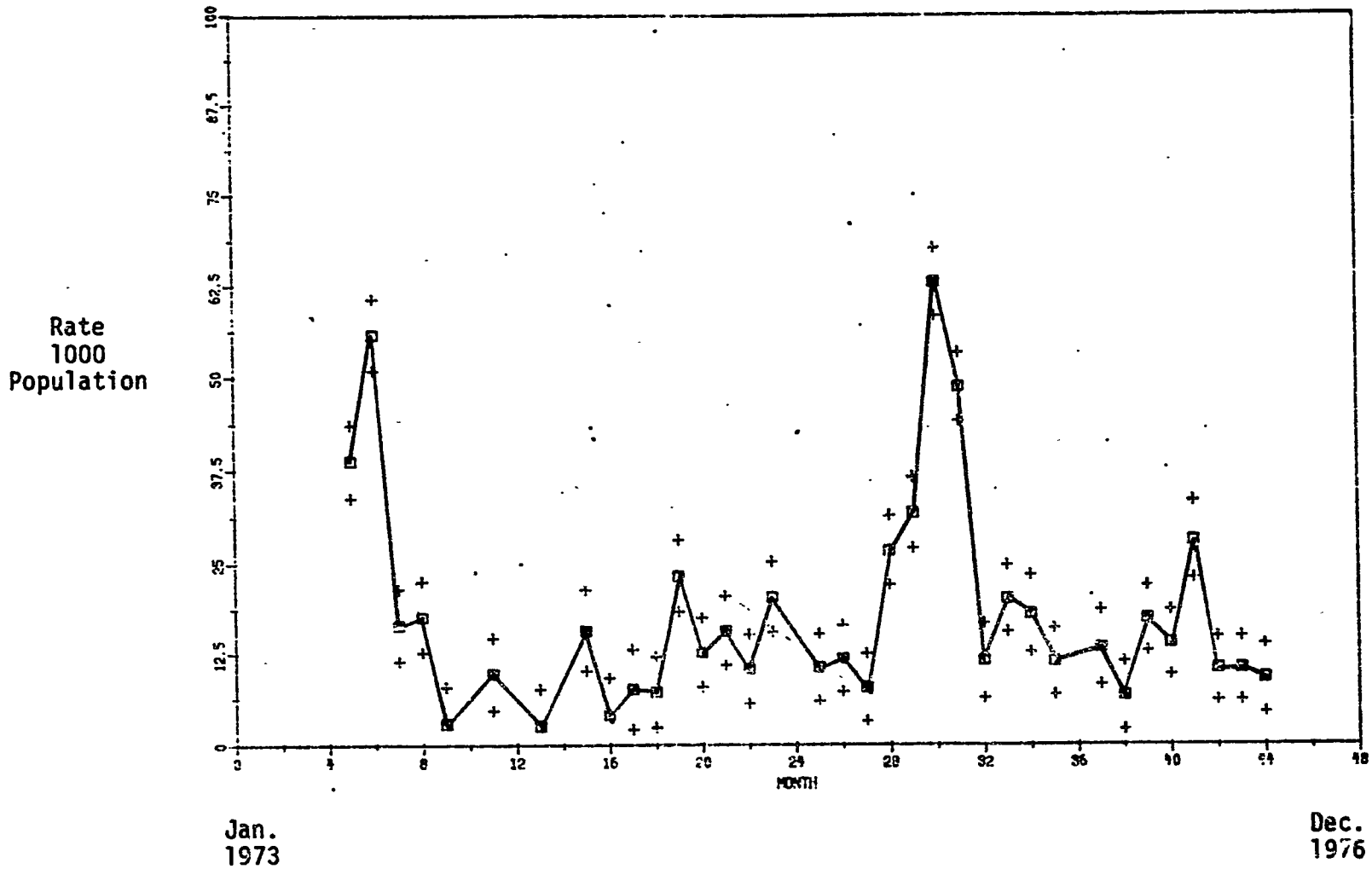
Jan.
1973

Dec.
1976

*Estimate of morbidity rate adjusted for families with five or more persons and the geometric mean of their water consumption.

257

Adjusted Infectious Disease Rate in Florida Aceituno*
(mean and standard deviation)



*Estimate of morbidity rate for families with five or more persons.

Respiratory Disease Morbidity Rate Descriptive Statistics
by Quarter and Village

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
UNIQFAM	4-DIGIT UNIQUE FAMILY ID		558	1195.751397	113.8538657	1001.000000	1385.00000	6.0173638
MORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY		558	4.625698	3.0723505	1.000000	21.00000	0.1623788
RESPOR01	QUARTERLY RESPIRATION DISEASE RATE,	QUARTER 1	209	11.674808	35.5903777	0.000000	181.81818	2.4618379
RESPOR02		QUARTER 2	212	10.867945	42.1689530	0.000000	250.00000	2.8961756
RESPOR03		QUARTER 3	212	30.522936	73.5566285	0.000000	500.00000	5.0518900
RESPOR04		QUARTER 4	198	33.109869	82.0098757	0.000000	600.00000	5.8281881
RESPOR05		QUARTER 5	219	84.200716	113.2571425	0.000000	500.00000	7.6532035
RESPOR06		QUARTER 6	231	50.492896	94.2019538	0.000000	500.00000	6.1980335
RESPOR07		QUARTER 7	231	109.306750	155.4053806	0.000000	1000.00000	10.2249234
RESPOR08		QUARTER 8	242	25.804851	59.0905870	0.000000	333.33333	3.7984868
RESPOR09		QUARTER 9	252	43.123913	85.9175301	0.000000	500.00000	5.4122957
RESPOR10		QUARTER 10	242	78.657577	114.4323177	0.000000	666.66667	7.3559880
RESPOR11		QUARTER 11	236	88.391789	143.4491010	0.000000	583.33333	9.3377411
RESPOR12		QUARTER 12	243	24.228332	71.5675996	0.000000	666.66667	4.5910637
RESPOR13		QUARTER 13	266	65.311676	114.2967180	0.000000	666.66667	7.0079814
RESPOR14		QUARTER 14	259	60.249350	187.8000885	0.000000	1000.00000	11.6693297
---------- VILL=GU ----------								
UNIQFAM	4-DIGIT UNIQUE FAMILY ID		318	2170.172956	95.9510175	2001.000000	2332.00000	5.3806659
MORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY		318	4.927673	3.4446211	1.000000	27.00000	0.1931648
RESPOR01	QUARTERLY RESPIRATION DISEASE RATE,	QUARTER 1	212	10.630313	37.4012278	0.000000	333.33333	2.5687269
RESPOR02		QUARTER 2	213	32.718210	88.5457633	0.000000	500.00000	6.0670557
RESPOR03		QUARTER 3	214	35.330691	98.3078411	0.000000	500.00000	6.7201857
RESPOR04		QUARTER 4	214	59.695179	120.6410571	0.000000	722.22222	8.2468529
RESPOR05		QUARTER 5	222	135.215598	173.2969968	0.000000	1000.00000	11.6309329
RESPOR06		QUARTER 6	221	89.734193	96.5670714	0.000000	444.44444	6.4958042
RESPOR07		QUARTER 7	222	60.182624	142.2281971	0.000000	1000.00000	9.5457316
RESPOR08		QUARTER 8	231	78.112478	133.7843043	0.000000	857.14286	8.8023610
RESPOR09		QUARTER 9	234	29.542003	69.9639962	0.000000	333.33333	4.5736895
RESPOR10		QUARTER 10	239	36.679441	70.3916412	0.000000	333.33333	4.5532568
RESPOR11		QUARTER 11	245	55.088103	125.3574400	0.000000	1000.00000	8.0087931
RESPOR12		QUARTER 12	248	40.033951	82.2475757	0.000000	375.00000	5.2227263
RESPOR13		QUARTER 13	253	55.834584	117.7948311	0.000000	1000.00000	7.4056976
RESPOR14		QUARTER 14	242	50.256332	142.9191846	0.000000	1000.00000	9.1871931

Respiratory Disease Morbidity by Season, Sex and Village
Rate/1000 Population

SEASON	FEMALE			MALE			BOTH		
	FA	GU	BOTH	FA	GU	BOTH	FA	GU	BOTH
1	15.5 2.76 1999	21.6 2.93 2454	18.9 2.04 4453	9.3 1.98 2358	13.1 2.23 2597	11.3 1.50 4955	12.2 1.66 4357	17.2 1.83 5051	14.9 1.25 9408
2	38.9 5.01 1491	53.0 5.16 1887	46.8 3.63 3378	37.3 4.51 1768	54.6 5.37 1794	46.0 3.51 3562	38.0 3.35 3259	53.8 3.72 3681	46.4 2.52 6940
3	68.1 5.14 2407	110.6 5.64 3093	92.0 3.90 5500	68.7 4.71 2081	108.2 5.58 3095	89.2 3.69 5176	68.5 3.47 5288	109.4 3.97 6188	90.5 2.68 11476
4	59.6 5.03 2214	73.5 5.12 2591	67.0 3.61 4805	52.0 4.37 2579	65.8 4.85 2612	58.9 3.27 5191	55.5 3.31 4793	69.6 3.53 5203	62.8 2.43 9996
5	68.5 4.82 2746	40.2 3.48 3184	53.3 2.92 5930	44.1 3.62 3218	29.1 2.86 3440	36.3 2.29 6658	55.3 2.96 5964	34.4 2.24 6624	44.3 1.83 12588
6	60.5 4.98 2296	57.7 4.47 2719	59.0 3.33 5015	39.6 3.79 2652	50.2 4.10 2830	45.1 2.80 5482	49.3 3.68 4948	53.9 3.03 5549	51.7 2.16 10497
7	71.3 5.90 1899	57.7 4.95 2217	63.9 3.81 4116	54.1 4.83 2198	48.0 4.37 2395	50.9 3.24 4593	62.0 3.77 4097	52.7 3.29 4612	57.1 2.49 8709
TOTAL	56.3 1.88 15052	60.5 1.77 18145	58.6 1.29 33197	44.5 1.55 17654	53.1 1.64 18763	48.9 1.13 36417	49.9 1.20 32706	56.7 1.20 36908	53.5 0.85 69614

Key: Rate/1000
Standard error
Number of persons
Time: May 1973 to October 1976

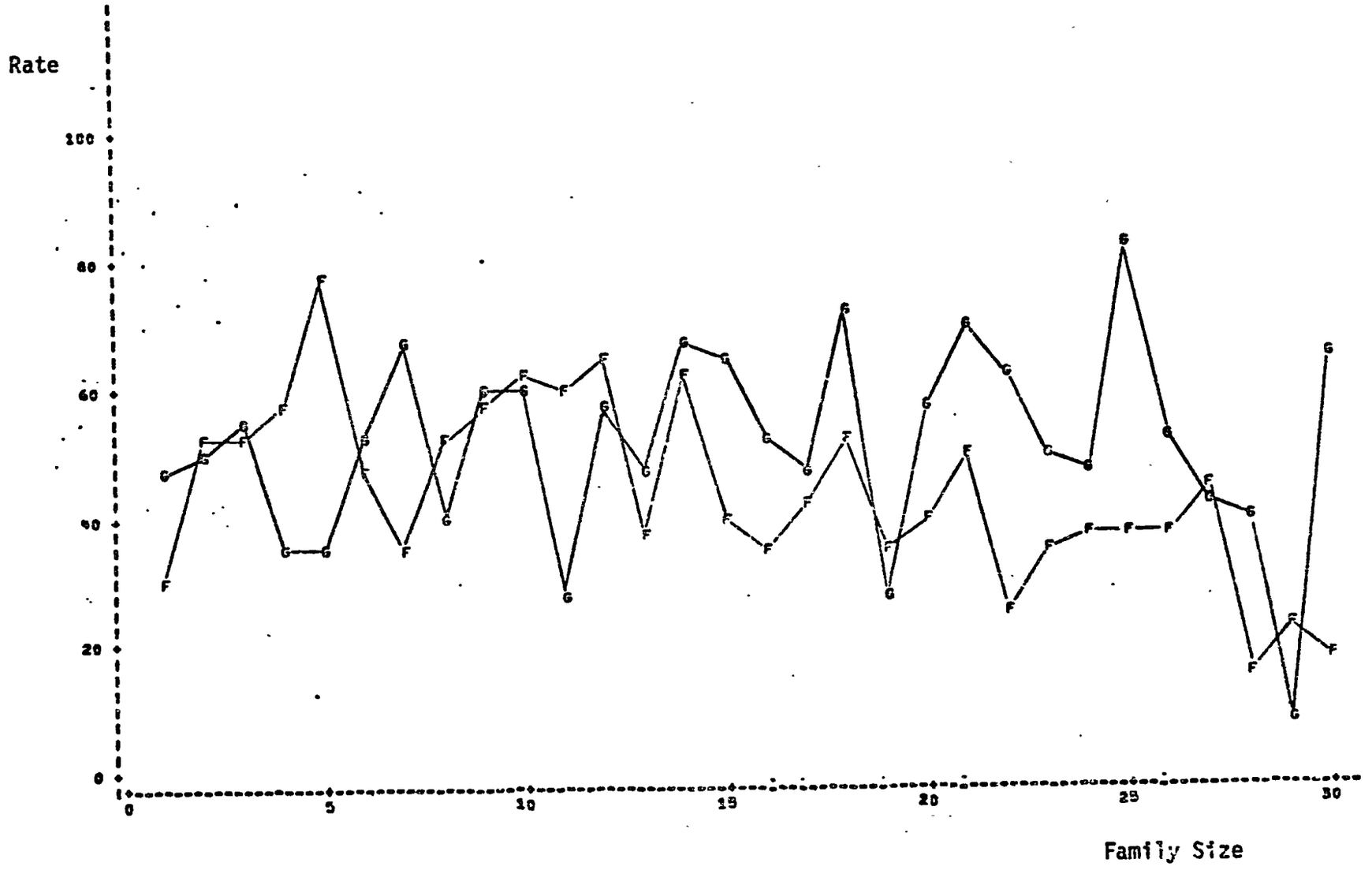
Respiratory Disease Morbidity by Age, Sex and Village
Rate/1000 Population

AGE CATEGORY	FEMALE FA	FEMALE GU	FEMALE BOTH	MALE FA	MALE GU	MALE BOTH	BOTH FA	BOTH GU	BOTH BOTH
AGE00-01	72.3 61 844	95.5 73 764	83.3 134 1608	86.2 74 858	81.2 53 653	84.1 127 1511	79.3 135 1702	88.9 126 1417	85.7 261 3119
AGE01-02	92.5 62 670	104.4 81 776	98.9 143 1446	113.0 74 655	108.8 68 625	110.9 142 1280	102.6 136 1325	106.4 149 1401	104.5 285 2726
AGE02-07	59.9 157 2615	74.7 232 3107	67.9 389 5726	63.0 165 2620	79.9 263 3290	72.4 428 5910	61.5 322 5239	77.4 495 6397	70.2 817 11636
AGE07-15	36.1 92 2546	49.5 218 4405	44.6 310 6951	29.4 95 3230	43.1 177 4107	37.1 272 7337	32.4 187 5776	46.4 395 8512	40.7 582 14288
AGE15-30	43.0 173 4022	41.6 174 4178	42.3 347 8200	26.6 118 4436	33.9 168 4956	30.5 286 9392	34.4 291 8458	37.4 342 9134	36.0 633 17592
AGE30-45	49.0 103 2068	63.4 158 2493	57.2 261 4561	43.4 127 2928	40.6 97 2389	42.1 224 5317	46.0 230 4996	52.2 255 4882	49.1 485 9878
AGE45-99	87.2 199 2283	66.9 162 2422	76.7 361 4705	45.4 133 2927	62.0 170 2743	53.4 303 5670	63.7 332 5210	64.3 332 5165	64.0 664 10375
TOTAL	56.3 847 15052	60.5 1098 18145	58.6 1945 33197	44.5 786 17654	53.1 998 18798	48.9 1784 36452	49.9 1633 32706	56.7 2096 36943	53.5 3729 69649

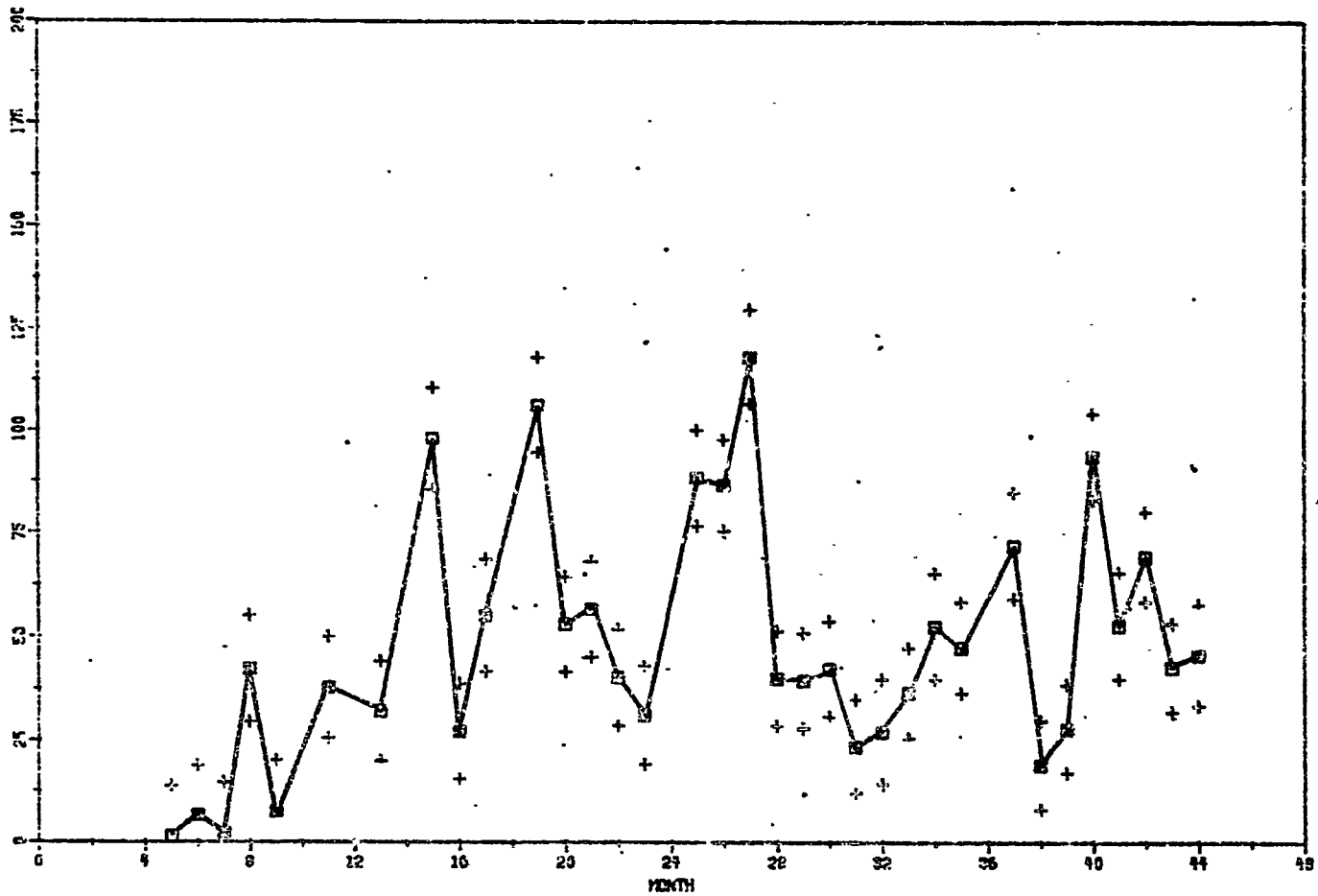
Key: Rate/1000
Numerator: cases
Denominator: population at risk

Mean Quarterly Respiratory Disease Rate Versus Family Size by Village

Rate/1000

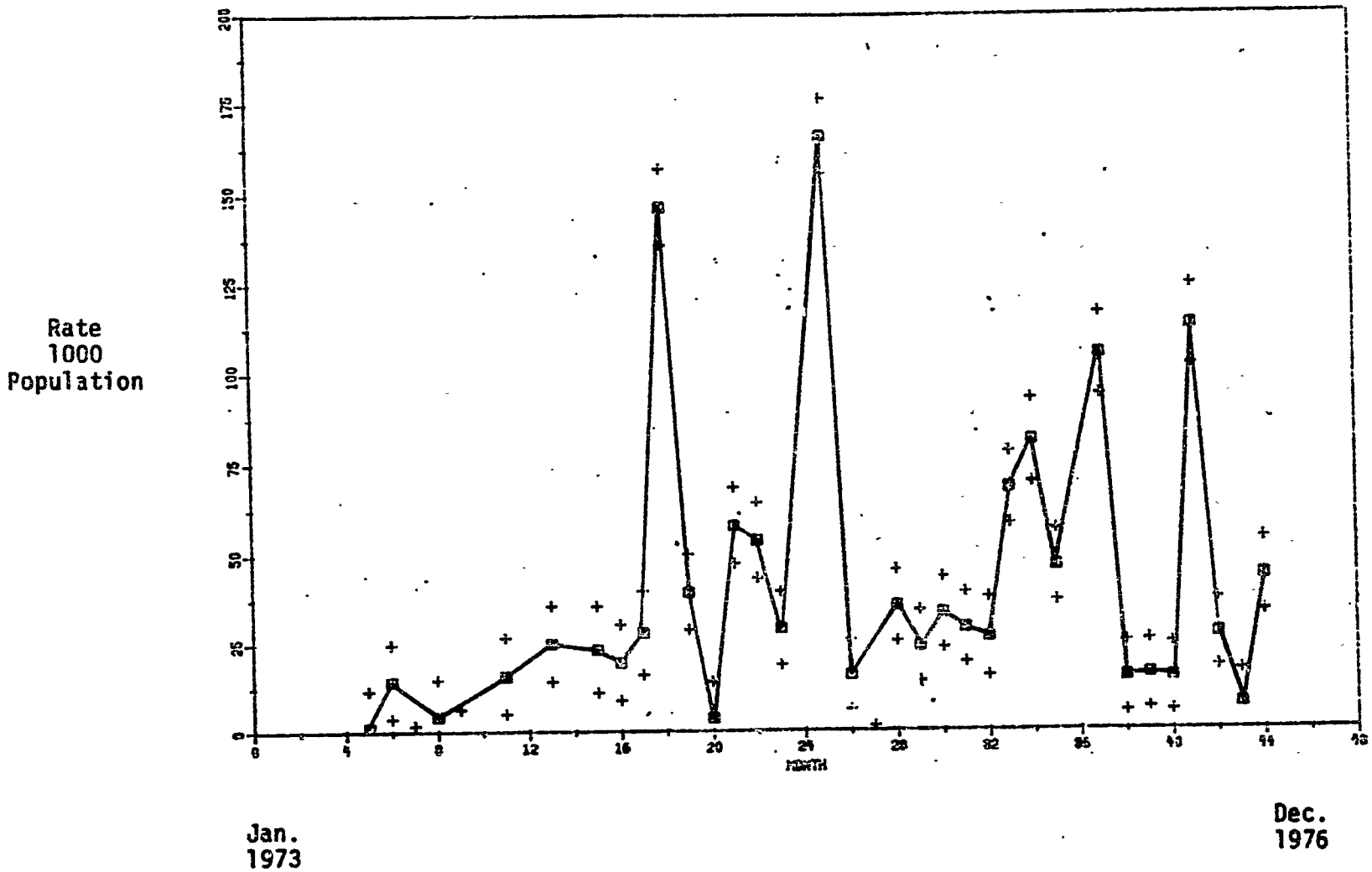


Adjusted Respiratory Disease Rate in Guanagazapa*
(mean and standard deviation)



*Estimate of morbidity rate adjusted for families with five or more persons and the geometric mean of their water consumption.

Adjusted Respiratory Disease Rate in Florida Aceituno*
(mean and standard deviation)



*Estimate of morbidity rate for families with five or more persons.

Skin Infections Morbidity Rate Descriptive Statistics
by Quarter and Village

VILL=FA

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
UNIQFAM	4-DIGIT UNIQUE FAMILY ID		398	1195.751397	113.8538457	1001.000000	1389.00000	6.01736378
MORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY		398	4.625698	3.0723505	1.000000	21.00000	0.16237877
SKINOR01	QUARTERLY SKIN INFECTION RATES,	QUARTER 1	209	10.238169	40.6757887	0.000000	333.33333	2.81360314
SKINOR02		QUARTER 2	212	8.554548	43.5903584	0.000000	500.00000	2.99379810
SKINOR03		QUARTER 3	212	5.180904	25.7505422	0.000000	166.66667	1.76855450
SKINOR04		QUARTER 4	198	3.033309	18.6762801	0.000000	166.66667	1.32726543
SKINOR05		QUARTER 5	219	0.883462	7.7543469	0.000000	83.33333	0.52399020
SKINOR06		QUARTER 6	231	4.479912	29.6083614	0.000000	333.33333	1.94808716
SKINOR07		QUARTER 7	231	4.152873	25.6964564	0.000000	250.00000	1.69070271
SKINOR08		QUARTER 8	242	4.835844	21.7109298	0.000000	166.66667	1.39563143
SKINOR09		QUARTER 9	252	5.295534	25.3696603	0.000000	266.66667	1.59813838
SKINOR10		QUARTER 10	242	7.879048	43.5779093	0.000000	500.00000	2.80129410
SKINOR11		QUARTER 11	236	5.155367	26.5849700	0.000000	250.00000	1.73053414
SKINOR12		QUARTER 12	243	4.232825	18.8202248	0.000000	142.85714	1.20731799
SKINOR13		QUARTER 13	266	6.527927	30.8604975	0.000000	333.33333	1.89217851
SKINOR14		QUARTER 14	259	7.944169	42.8785916	0.000000	333.33333	2.66434605

VILL=GU

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
UNIQFAM	4-DIGIT UNIQUE FAMILY ID		318	2170.172956	95.94101746	2001.000000	2332.00000	5.38066587
MORBPER	NUMBER OF PERSONS PRESENT FOR MORBIDITY		318	4.927673	3.44462113	1.000000	27.00000	0.19316476
SKINOR01	QUARTERLY SKIN INFECTION RATES,	QUARTER 1	212	23.323800	65.94061187	0.000000	666.66667	4.53750018
SKINOR02		QUARTER 2	215	19.741601	71.76208352	0.000000	625.00000	4.89294581
SKINOR03		QUARTER 3	214	15.403327	59.10872039	0.000000	500.00000	4.04058894
SKINOR04		QUARTER 4	214	8.377857	36.70429033	0.000000	333.33333	2.50905363
SKINOR05		QUARTER 5	222	14.584691	76.09241461	0.000000	1000.00000	5.10698848
SKINOR06		QUARTER 6	221	10.775030	34.26684398	0.000000	250.76923	2.30503737
SKINOR07		QUARTER 7	222	7.335387	32.70369388	0.000000	250.00000	2.19492822
SKINOR08		QUARTER 8	231	8.612829	21.56546005	0.000000	222.22222	1.41890369
SKINOR09		QUARTER 9	234	9.077969	40.19274991	0.000000	400.00000	2.62748226
SKINOR10		QUARTER 10	239	8.005926	32.49814514	0.000000	266.66667	2.10213026
SKINOR11		QUARTER 11	245	8.588435	34.72056655	0.000000	250.00000	2.21873312
SKINOR12		QUARTER 12	248	8.672206	30.51566412	0.000000	250.76923	1.93774661
SKINOR13		QUARTER 13	243	6.527069	30.70401654	0.000000	333.33333	1.93034498
SKINOR14		QUARTER 14	242	15.799226	75.59823502	0.000000	600.00000	4.85912438

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Skin Infections Morbidity by Season, Sex and Village
Rate/1000 Population

SEASON	FEMALE			MALE			BOTH		
	FA	GU	BOTH	FA	GU	BOTH	FA	GU	BOTH
1	8.0 1.99 1999	24.0 3.09 2454	16.8 1.93 4453	11.0 2.15 2358	23.9 3.00 2597	17.8 1.88 4955	9.6 1.48 4357	24.0 2.15 5051	17.3 1.35 9408
2	4.7 1.77 1491	11.7 2.47 1887	8.6 1.59 3378	4.5 1.60 1768	13.4 2.71 1794	9.0 1.58 3562	4.6 1.19 3259	12.5 1.83 3681	8.8 1.12 6940
3	2.9 1.10 2407	14.2 2.13 3093	9.3 1.29 5500	1.7 0.78 2881	10.7 1.85 3095	6.4 1.03 5976	2.3 0.65 5288	12.4 1.41 6188	7.6 0.82 11476
4	5.4 1.56 2214	8.1 1.76 2591	6.9 1.19 4805	3.9 1.22 2579	7.3 1.66 2612	5.6 1.03 5191	4.6 0.98 4793	7.7 1.21 5203	6.2 0.79 9996
5	5.5 1.41 2746	11.3 1.87 3184	8.6 1.20 5930	6.8 1.45 3218	6.1 1.33 3440	6.5 0.98 6658	6.2 1.02 5964	8.6 1.13 6624	7.5 0.77 12588
6	6.5 1.60 2296	8.8 1.79 2719	7.6 1.24 5015	3.8 1.19 2652	11.3 1.99 2830	7.7 1.18 5482	5.1 1.01 4948	10.1 1.34 5549	7.7 0.85 10497
7	4.7 1.58 1899	11.3 2.24 2217	8.3 1.41 4116	8.6 1.97 2198	7.1 1.72 2395	7.8 1.30 4593	6.8 1.29 4097	9.1 1.40 4612	8.0 0.96 8709
TOTAL	5.4 0.60 15052	12.7 0.83 18145	9.4 0.53 33197	5.7 0.56 17654	11.1 0.76 18763	8.5 0.48 36417	5.5 0.41 32706	11.9 0.56 36908	8.9 0.36 69614

Key: Rate/1000
Standard error
Number of persons
Time: May 1973 to October 1976

Skin Infections Morbidity by Age, Sex and Village
Rate/1000 Population

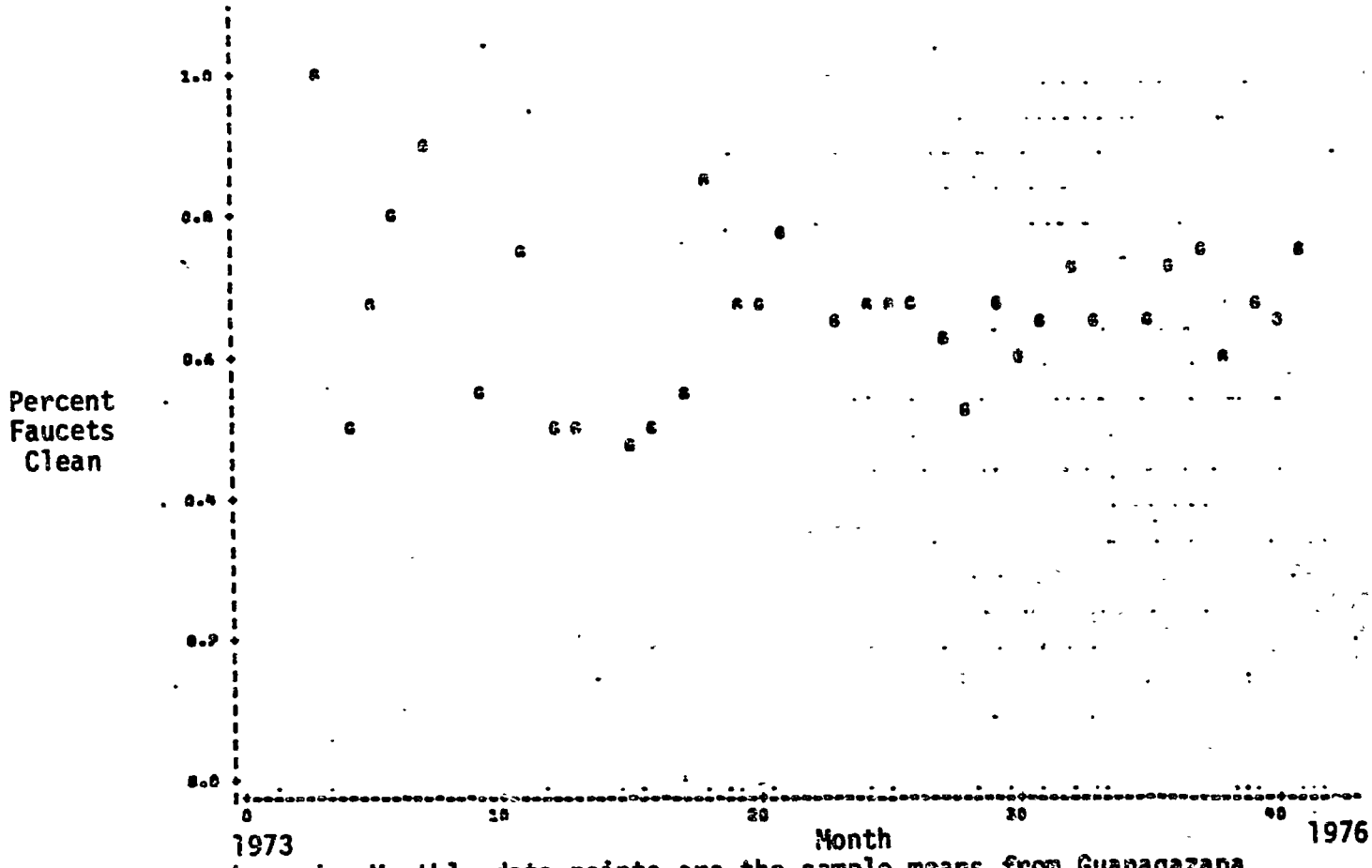
AGE CATEGORY	FEMALE FA	FEMALE GU	FEMALE BOTH	MALE FA	MALE GU	MALE BOTH	BOTH FA	BOTH GU	BOTH BOTH
AGE00-01	7.1 6 844	32.7 25 764	19.3 31 1608	9.3 8 858	27.6 18 653	17.2 26 1511	8.2 14 1702	30.3 43 1417	18.3 57 3119
AGE01-02	11.9 8 670	41.2 32 776	27.7 40 1446	19.8 13 655	28.8 18 625	24.2 31 1280	15.0 21 1325	35.7 50 1401	26.0 71 2726
AGE02-07	8.8 23 2619	23.5 73 3107	16.8 96 5726	7.6 20 2620	24.0 79 3290	16.8 99 5910	8.2 43 5239	23.8 152 6397	16.0 195 11636
AGE07-15	5.5 14 2546	6.8 30 4405	6.3 44 6951	4.0 13 3230	7.3 30 4107	5.9 43 7337	4.7 27 5776	7.0 60 8512	6.1 87 14208
AGE15-30	4.5 18 4022	7.4 31 4178	6.0 49 8200	4.1 18 4436	6.7 33 4956	5.4 51 9392	4.3 36 8458	7.0 64 9134	5.7 100 17592
AGE30-45	3.4 7 2068	7.2 18 2493	5.5 25 4561	4.4 13 2928	5.4 13 2389	.9 26 5317	4.0 20 4996	6.3 31 4882	5.2 51 9878
AGE45-99	2.2 5 2283	9.1 22 2422	5.7 27 4705	5.1 15 2927	6.2 17 2743	5.6 32 5670	3.8 20 5210	7.6 39 5165	5.7 59 10375
TOTAL	5.4 81 15032	12.7 231 18145	9.4 312 33197	5.7 100 17654	11.1 208 18798	8.4 308 36452	5.3 181 32706	11.9 439 36943	8.9 620 69649

Key: Rate/1000
Numerator: cases
Denominator: population at risk

APPENDIX IV

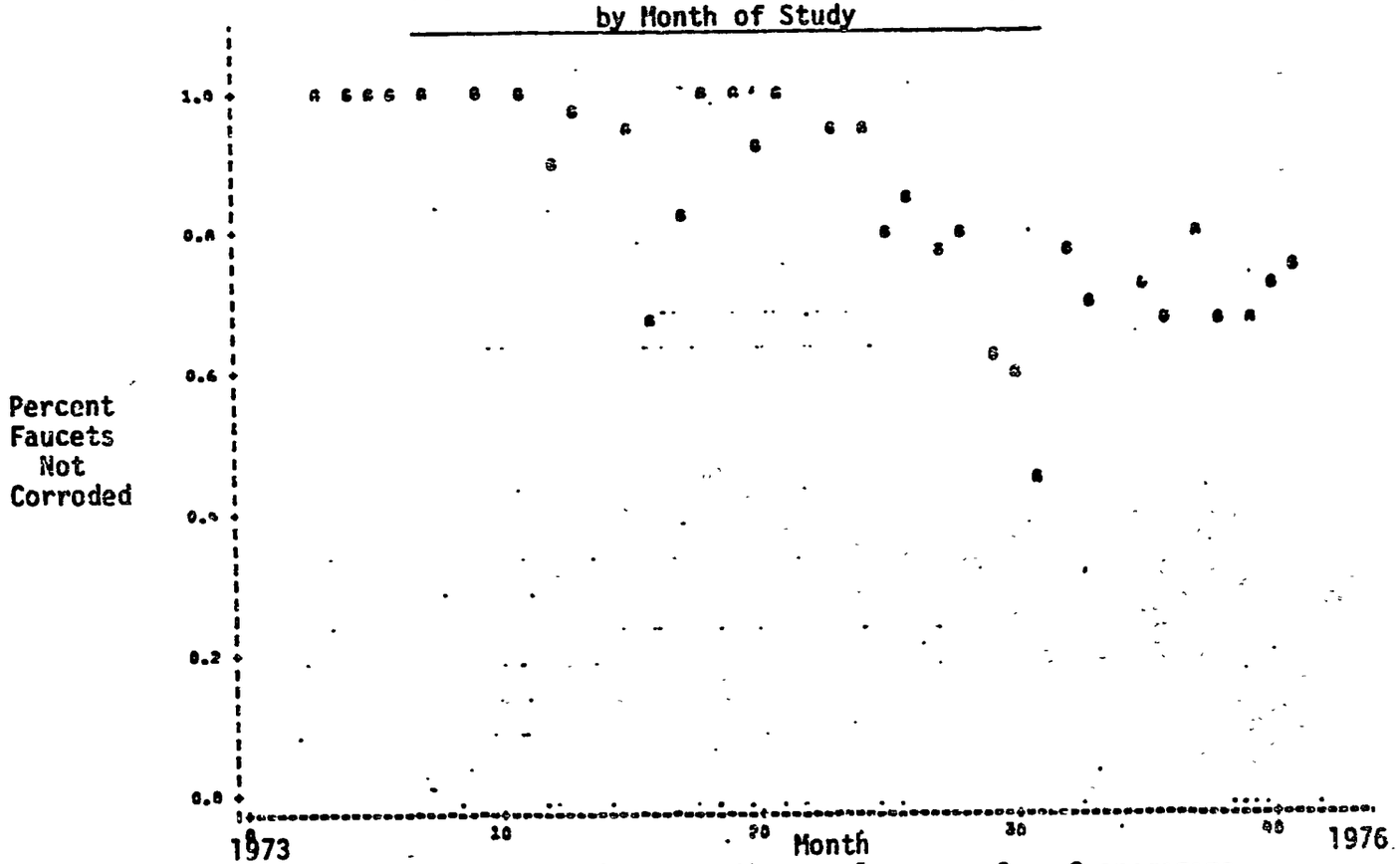
Water and Sanitation

Protection of Water Source in Guanagazapa
by Month of Study



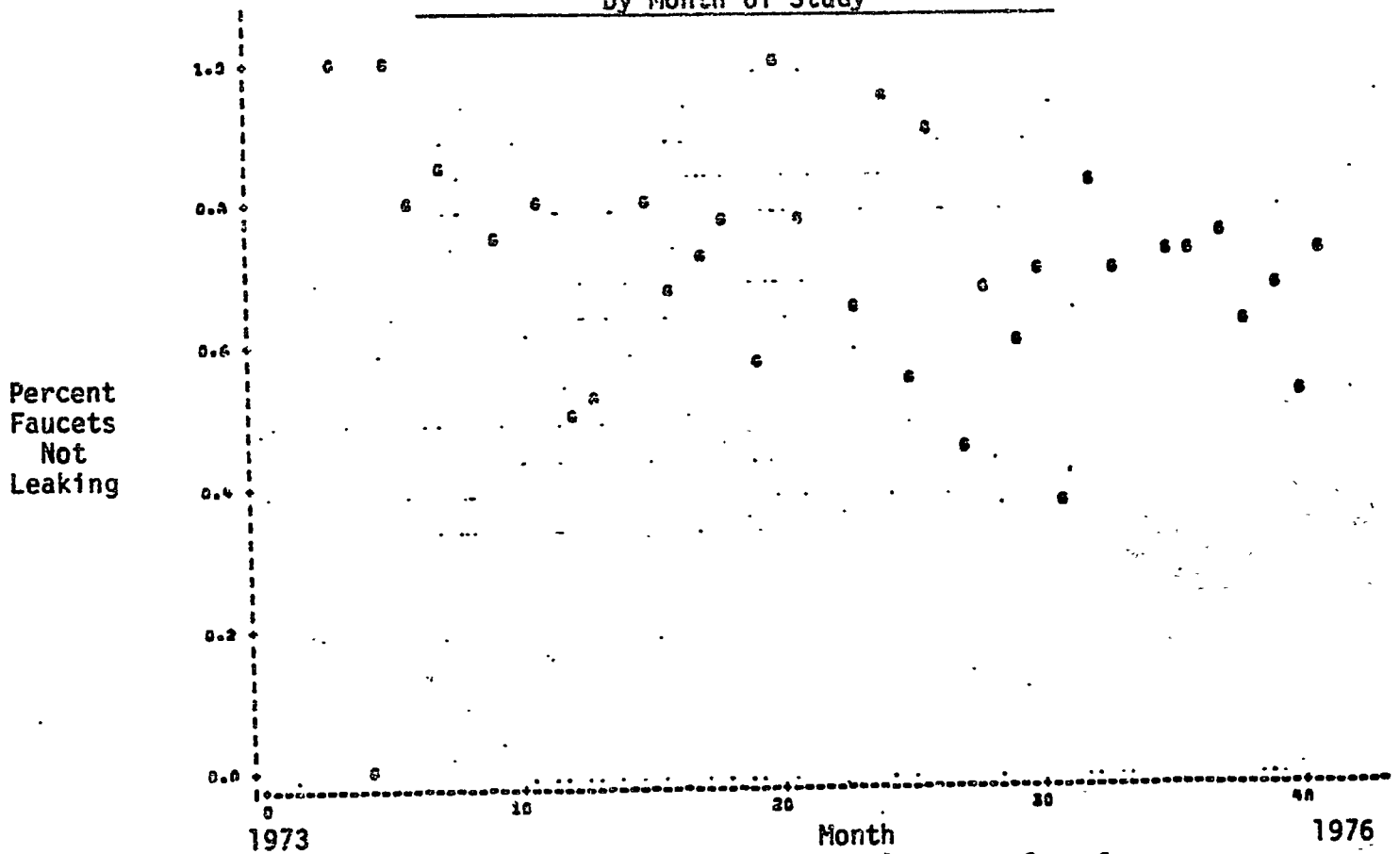
Legend: Monthly data points are the sample means from Guanagazapa.

Protection of Water Source in Guanagazapa
by Month of Study



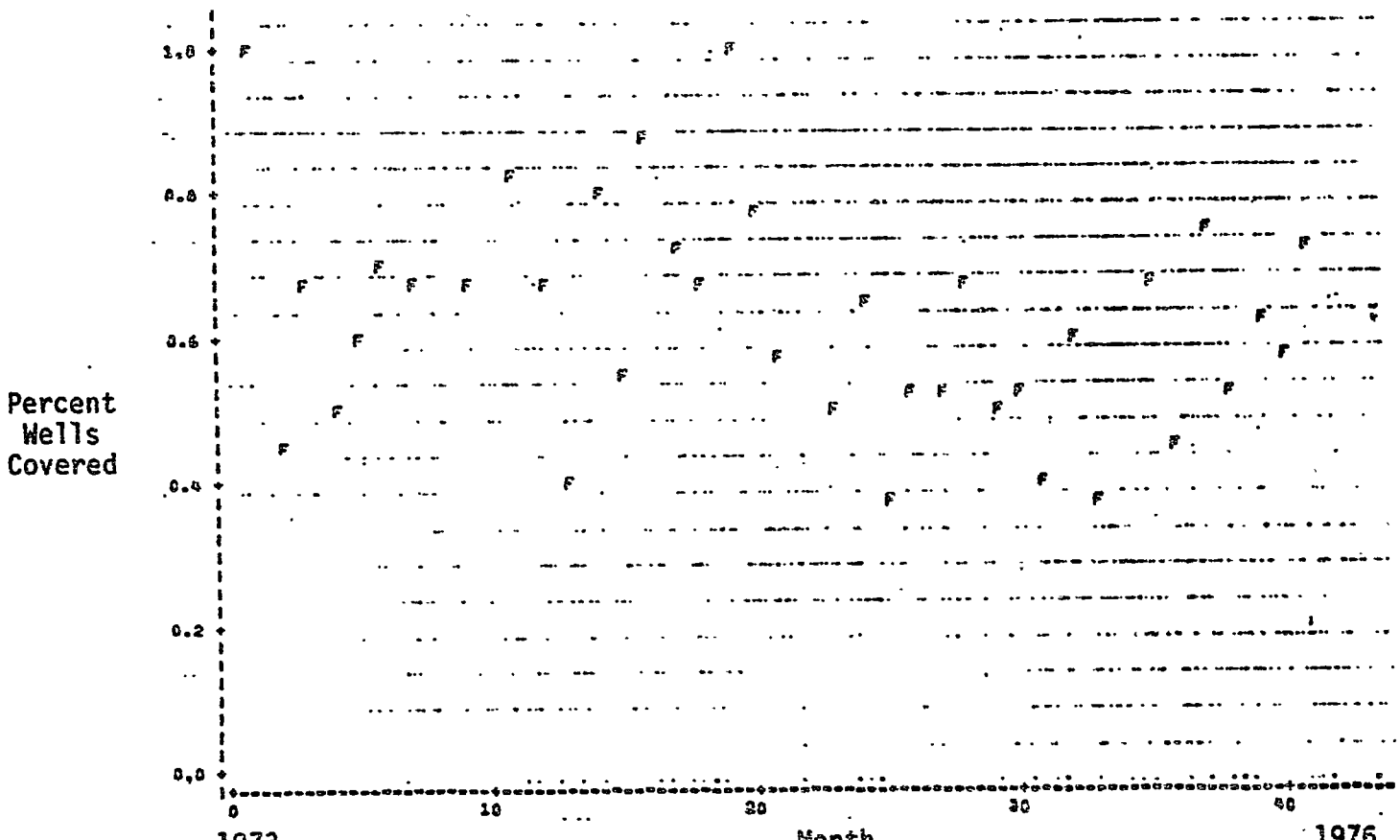
Legend: Monthly data points are the sample means from Guanagazapa.

Protection of Water Source in Guanagazapa
by Month of Study



Legend: Monthly data points are the sample means from Guanagazapa.

Protection of Water Source in Florida Aceituno
by Month of Study



Legend: Monthly data points are the sample means from Florida Aceituno.

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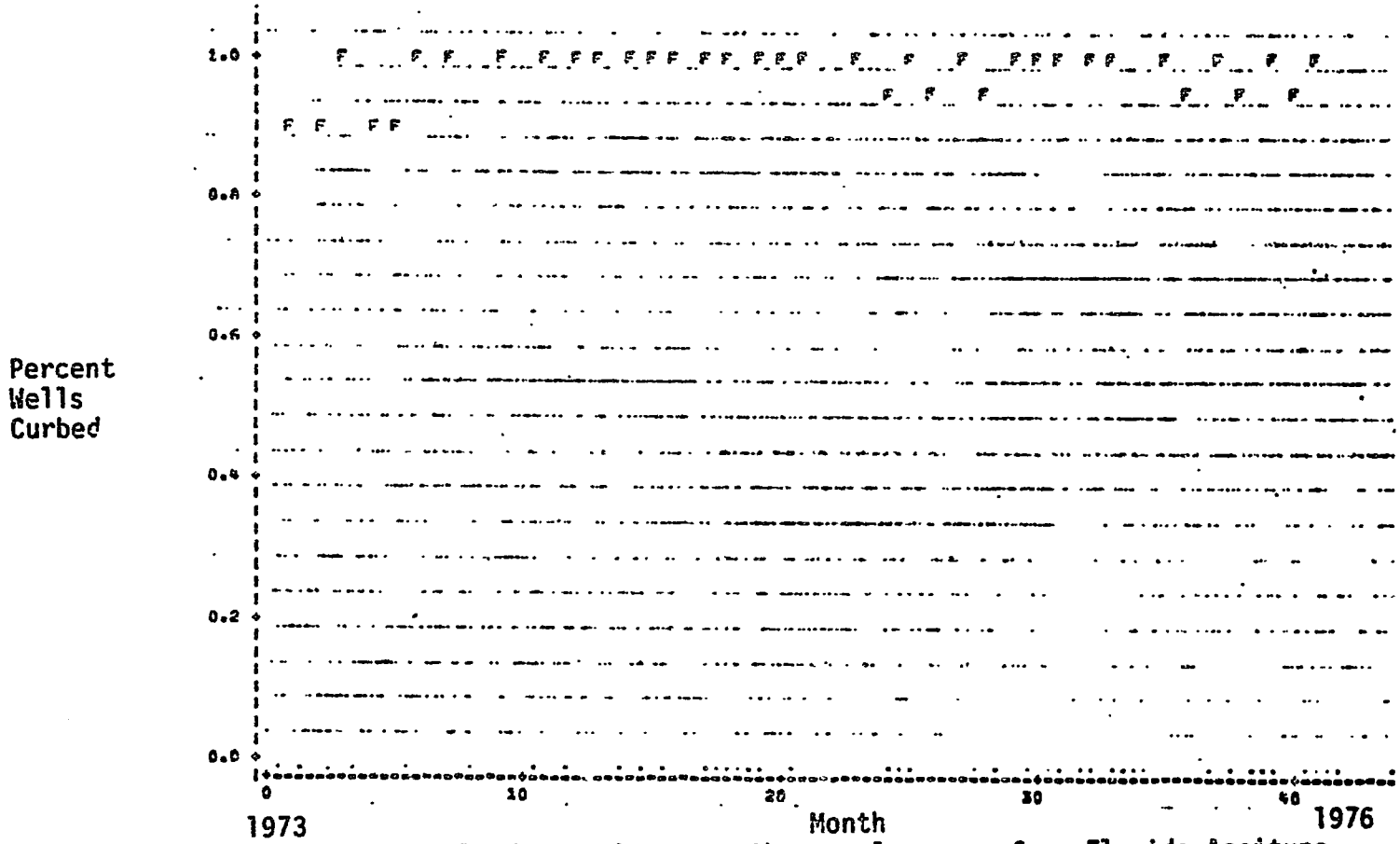
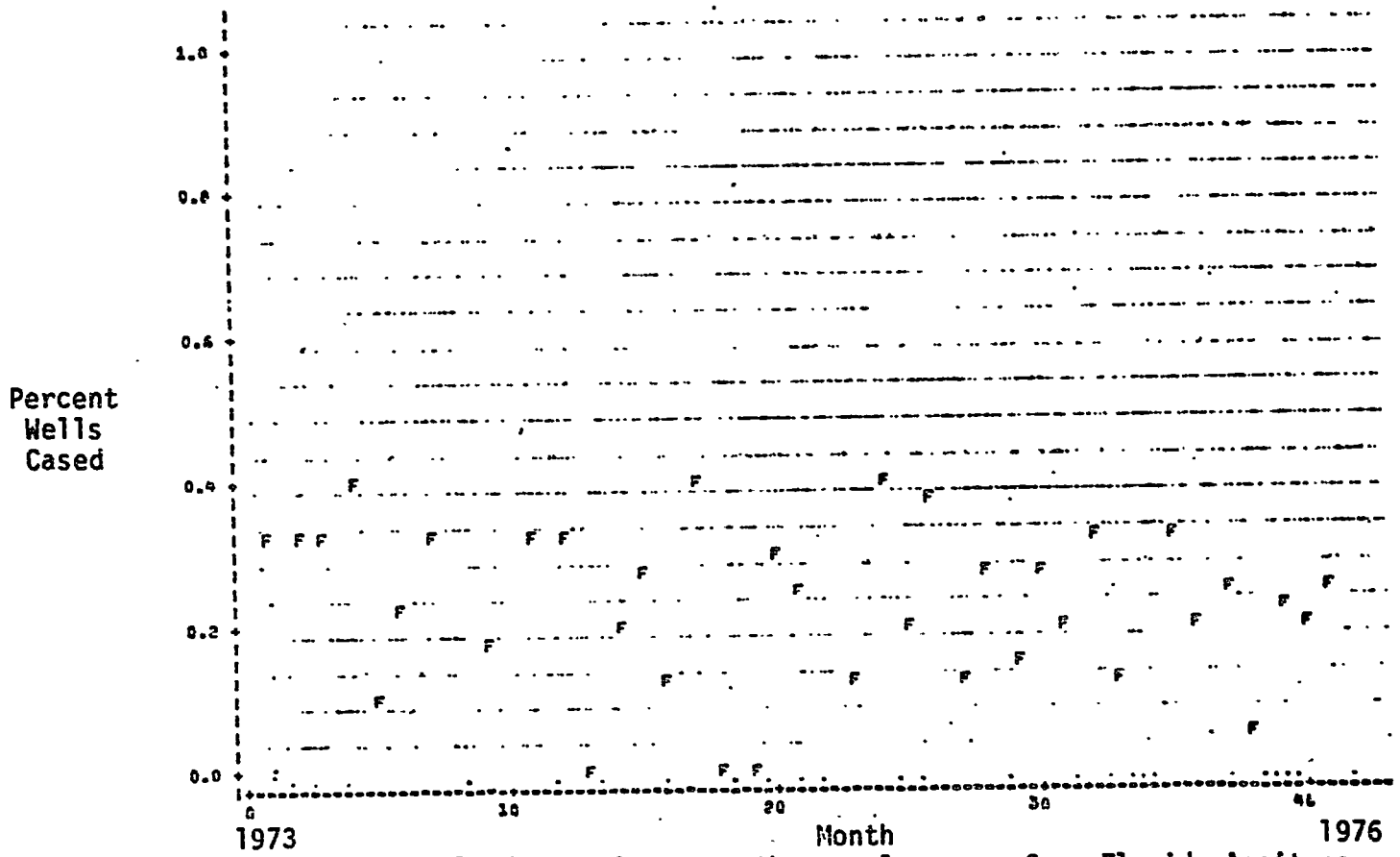
Protection of Water Source in Florida Aceituno
by Month of Study



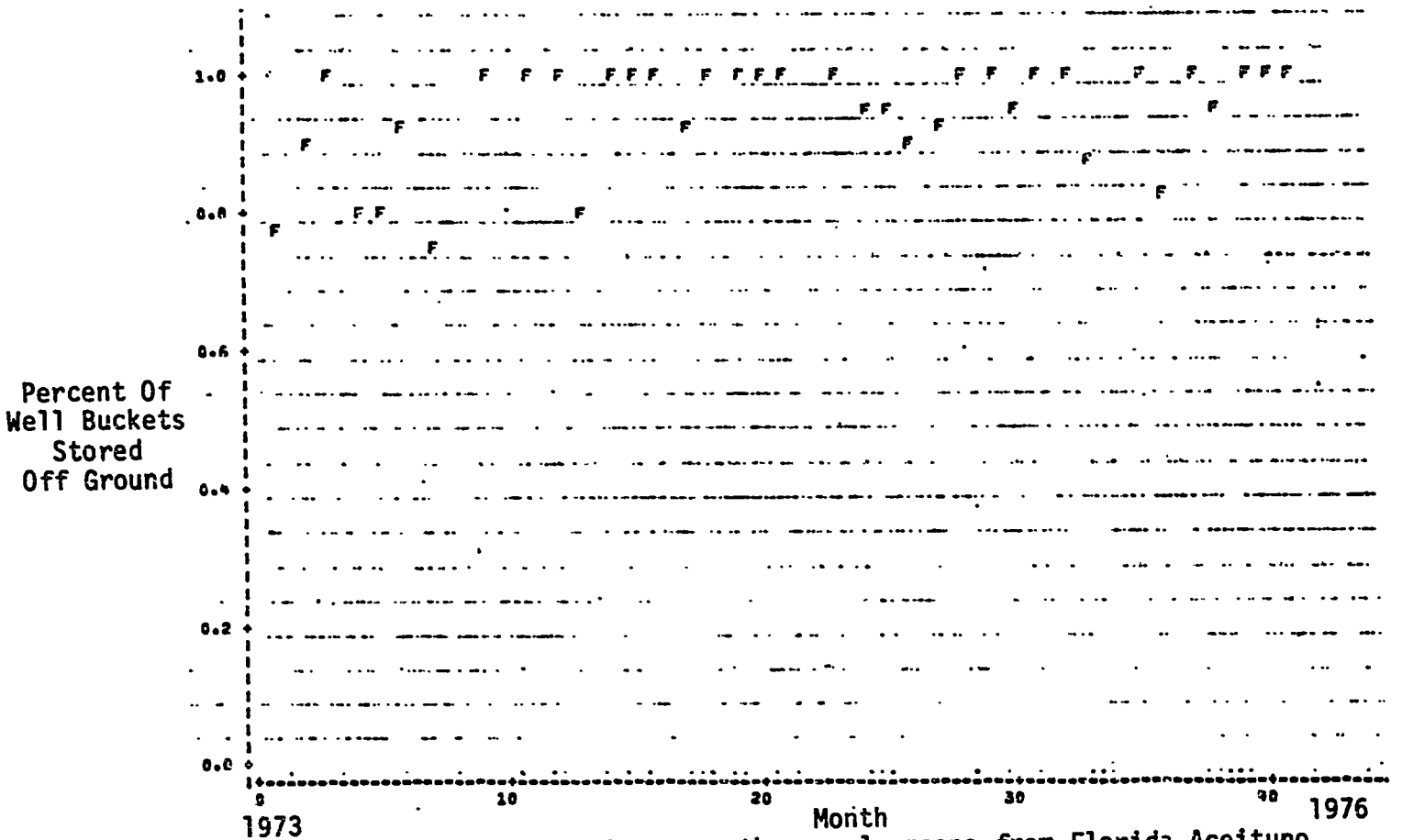
Legend: Monthly data points are the sample means from Florida Aceituno.

Protection of Water Source in Florida Aceituno
by Month of Study



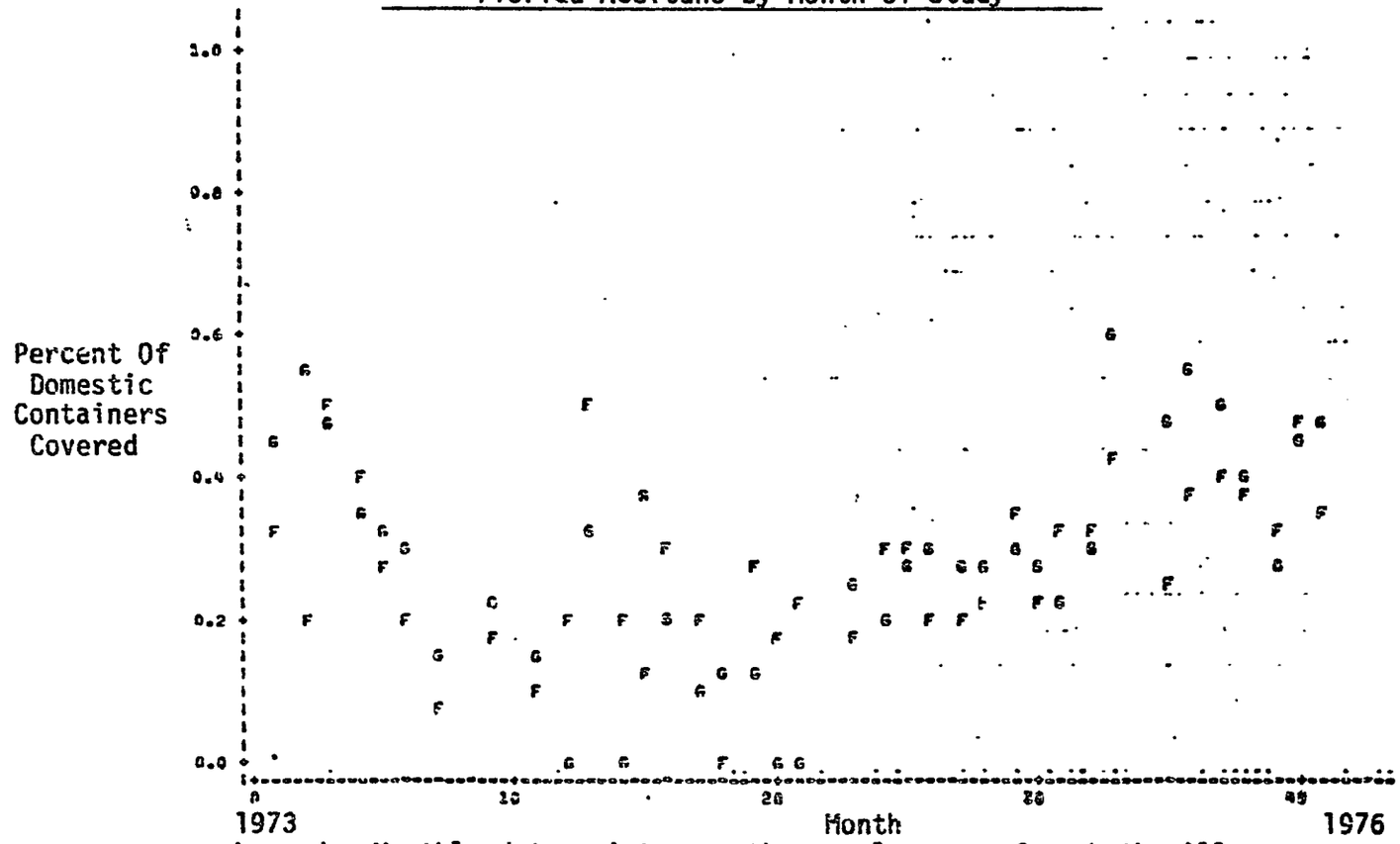
Legend: Monthly data points are the sample means from Florida Aceituno.

Protection of Water Source in Florida Aceituno
by Month of Study



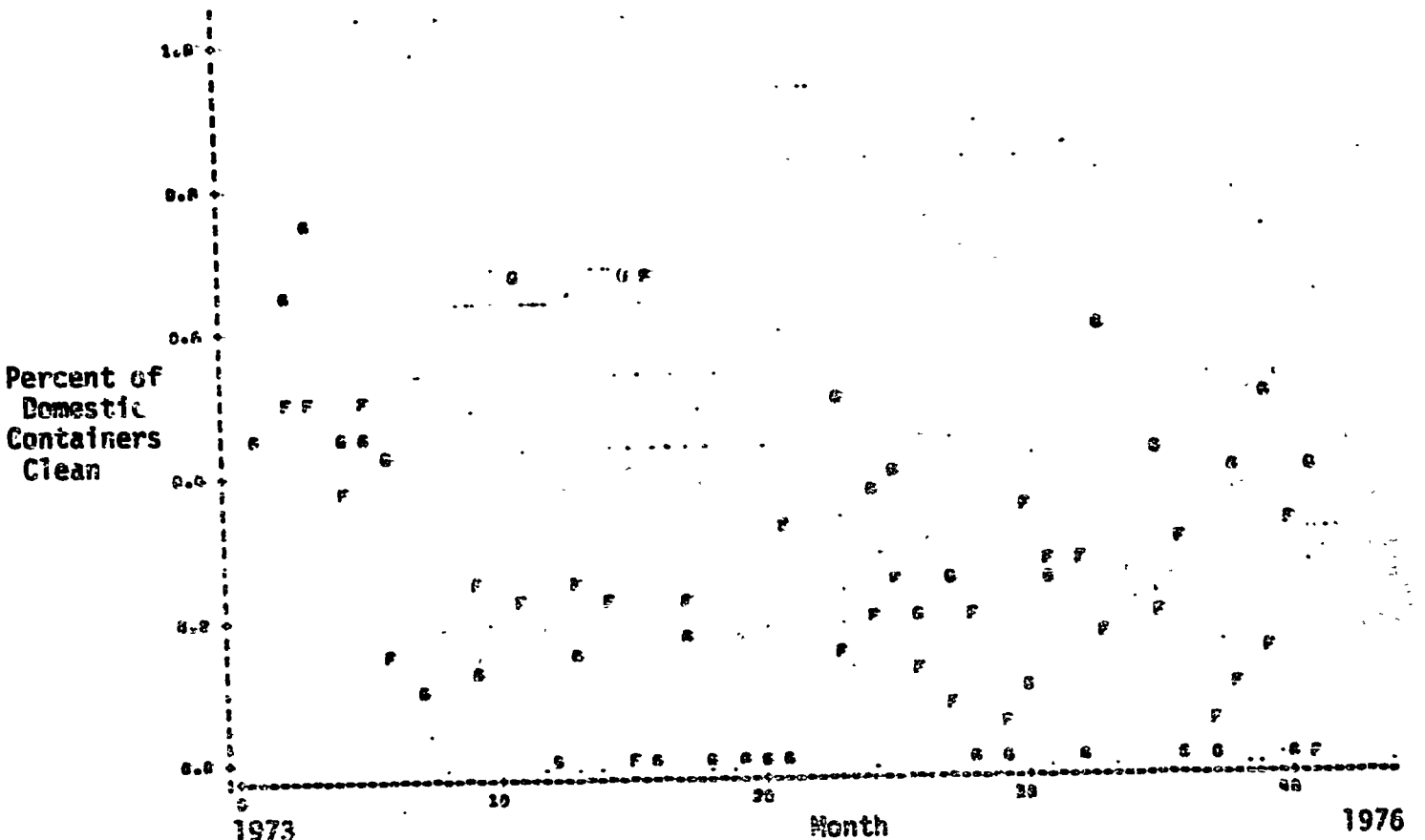
Legend: Monthly data points are the sample means from Florida Aceituno.

Protection of Water Quality in Guanagazapa and Florida Aceituno by Month of Study



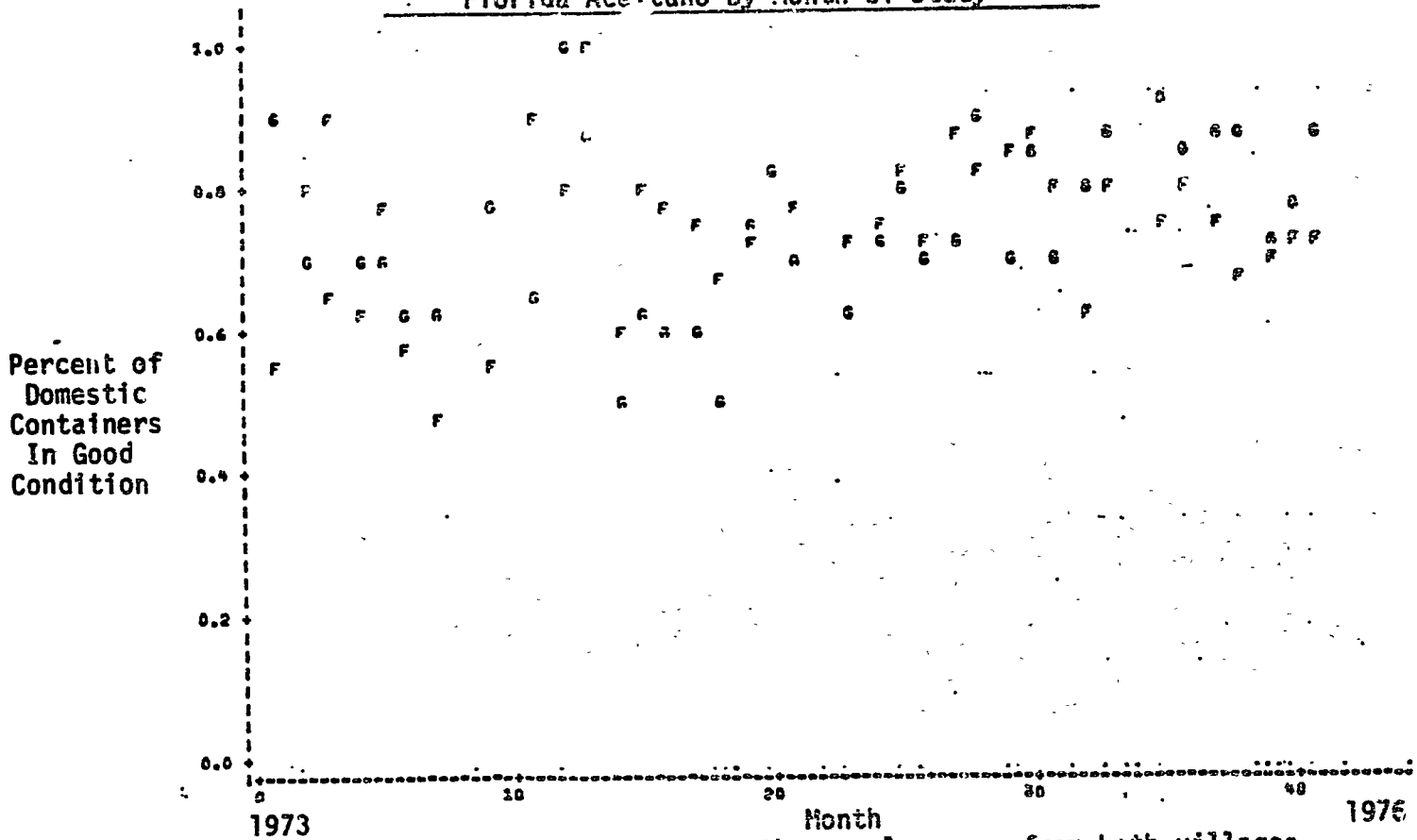
Legend: Monthly data points are the sample means from both villages.

Protection of Water Quality in Guanagazapa and Florida Aceituno by Month of Study



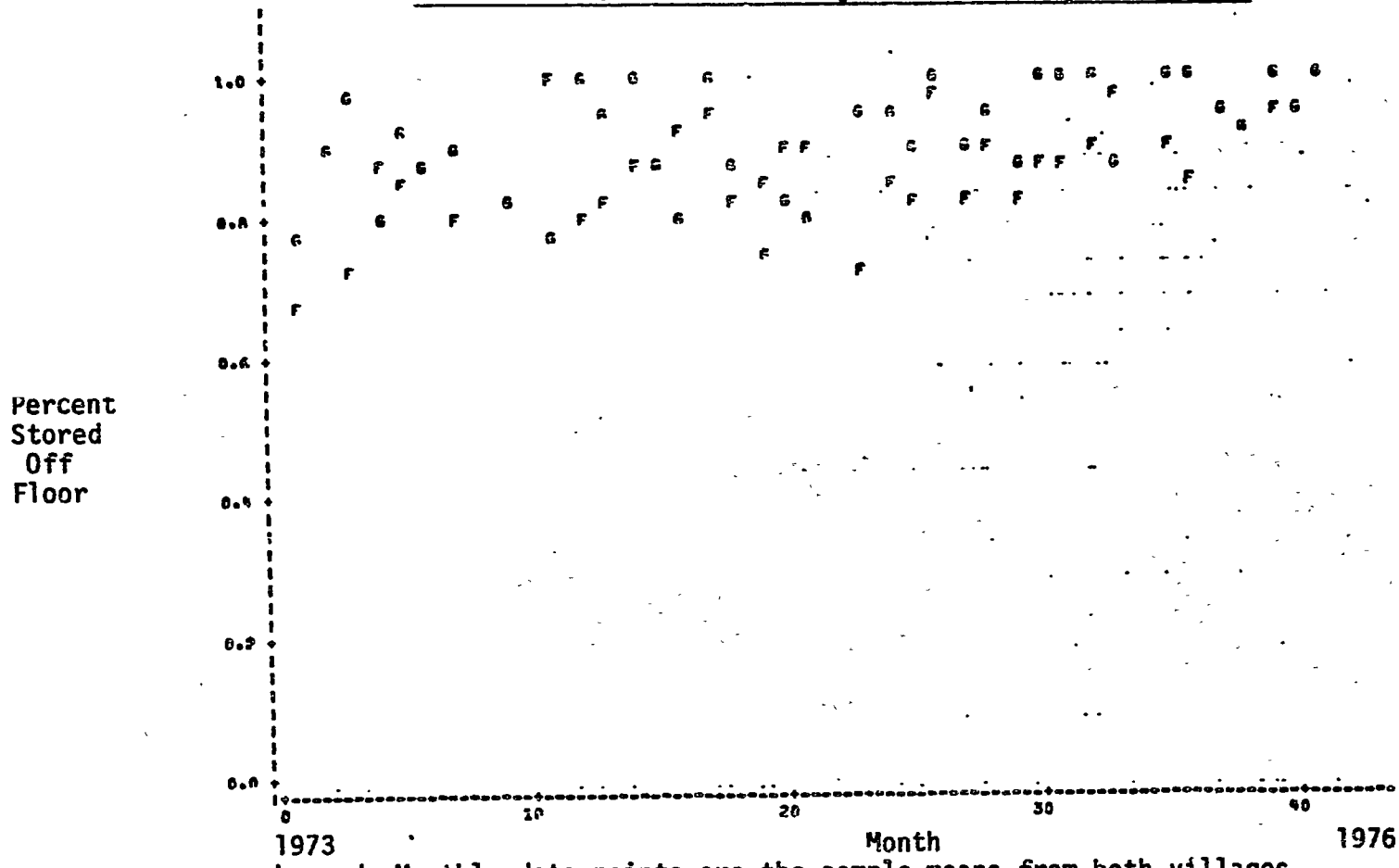
Legend: Monthly data points are the sample means from both villages.

Protection of Water Quality in Guanagazapa and Florida Aceituno by Month of Study



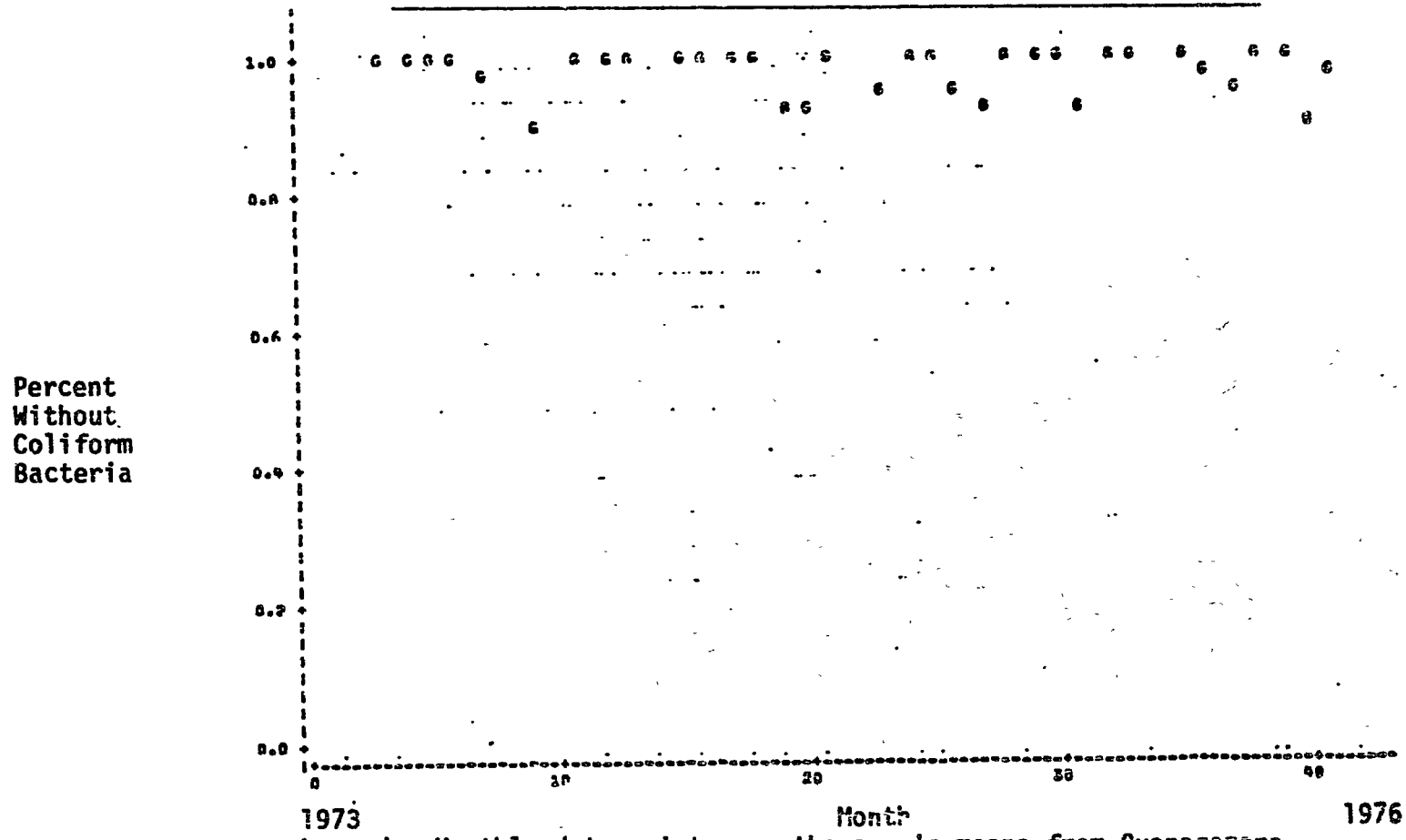
Legend: Monthly data points are the sample means from both villages.

Storage of Domestic Water Containers in Guanagazapa and Florida Aceituno by Month of Study



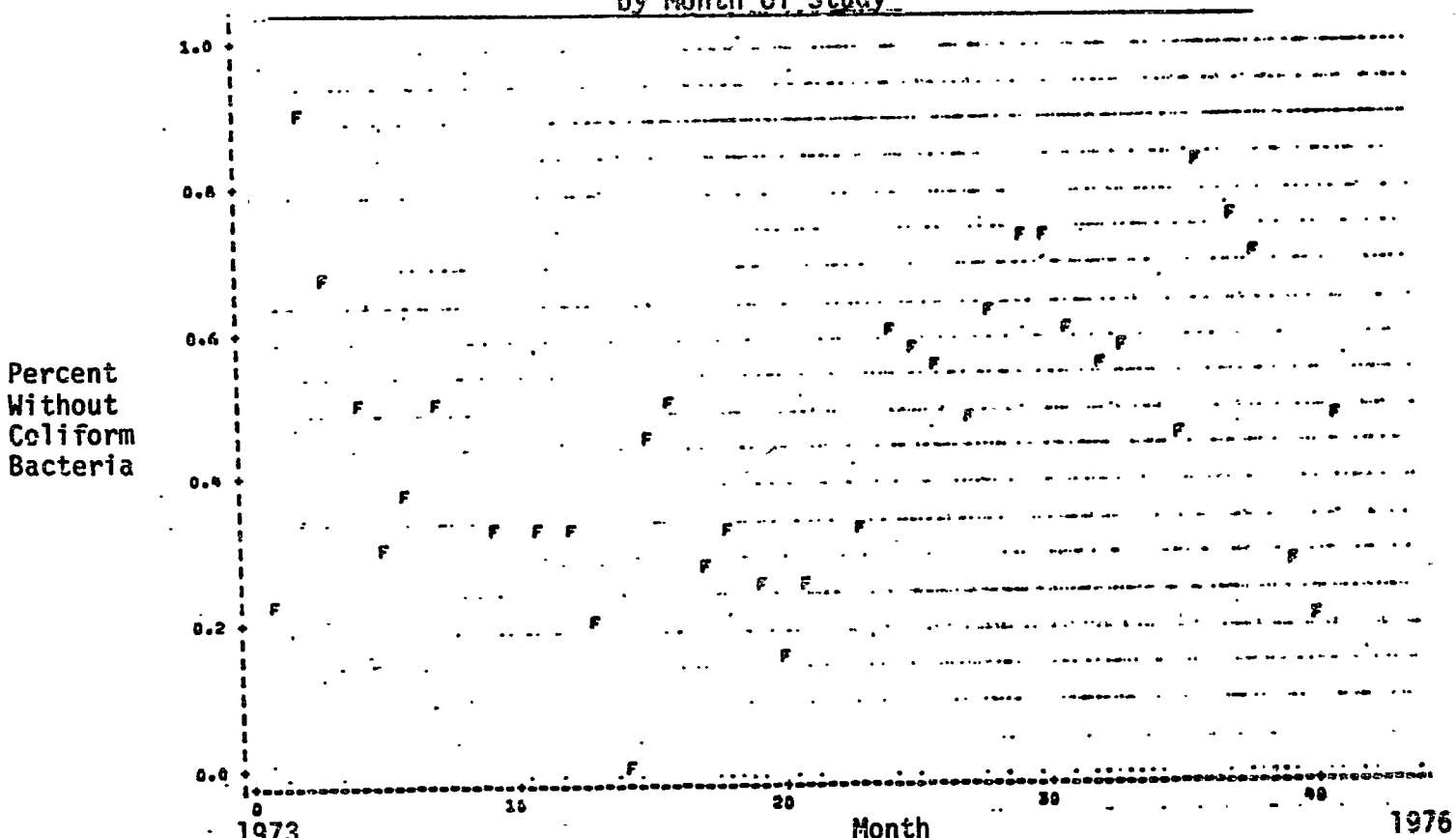
Legend: Monthly data points are the sample means from both villages.

Bacteriological Water Quality (From Faucet) in Guanagazapa
By Month of Study



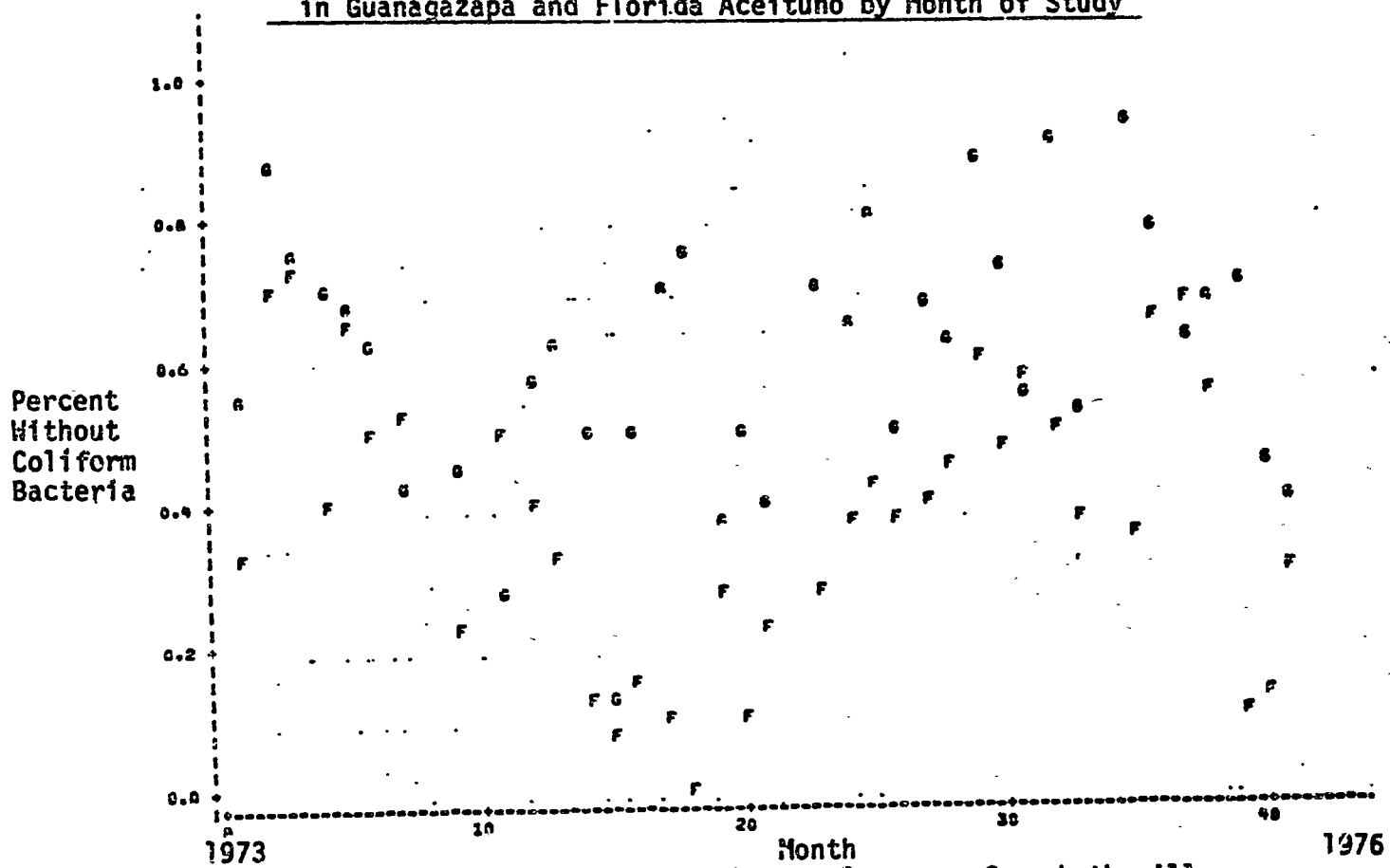
Legend: Monthly data points are the sample means from Guanagazapa.

Bacteriological Water Quality (From Wells) in Florida Aceituno
by Month of Study



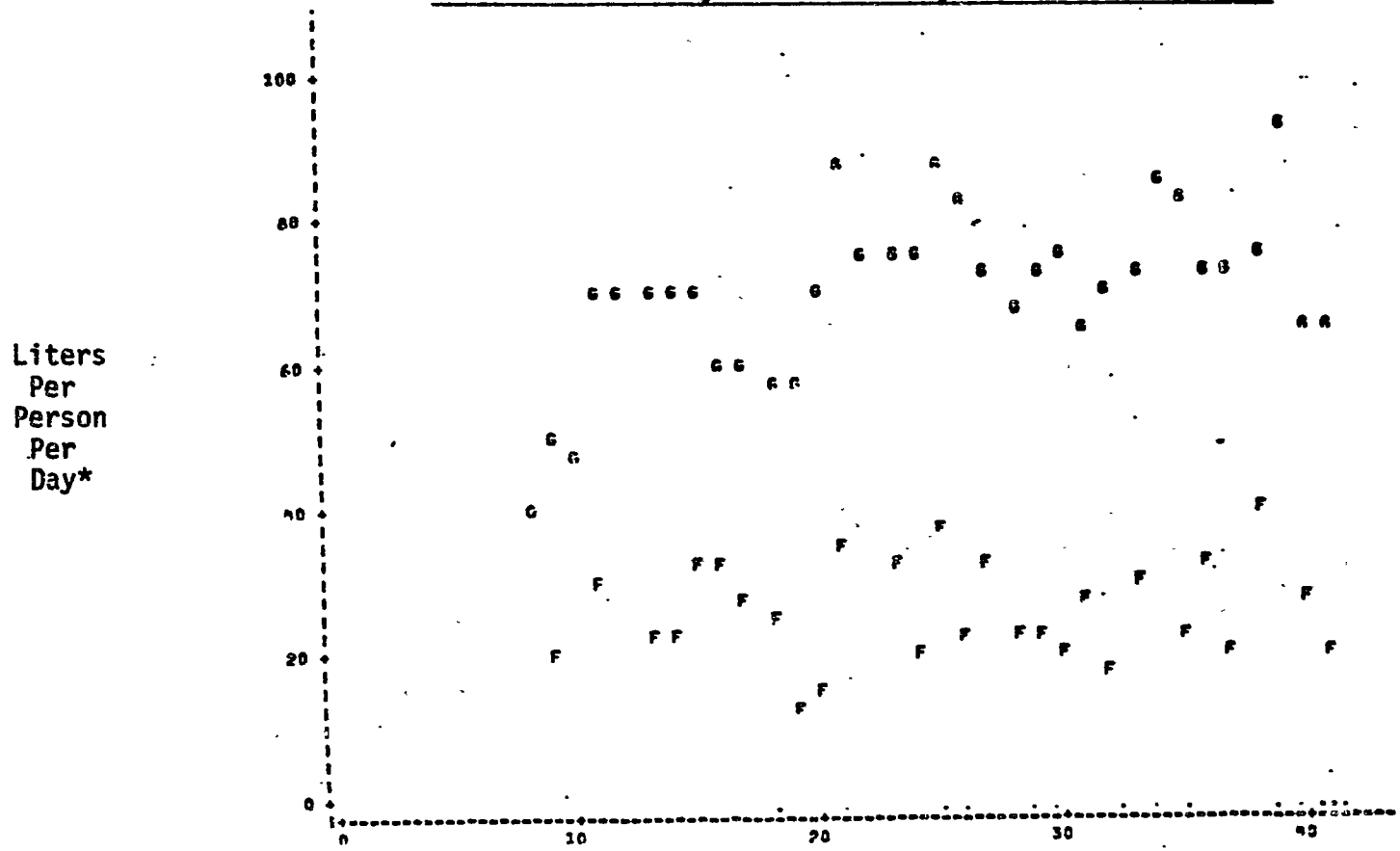
Legend: Monthly data points are the sample means from Florida Aceituno.

Bacteriological Water Quality (From Domestic Containers) in Guanagazapa and Florida Aceituno by Month of Study



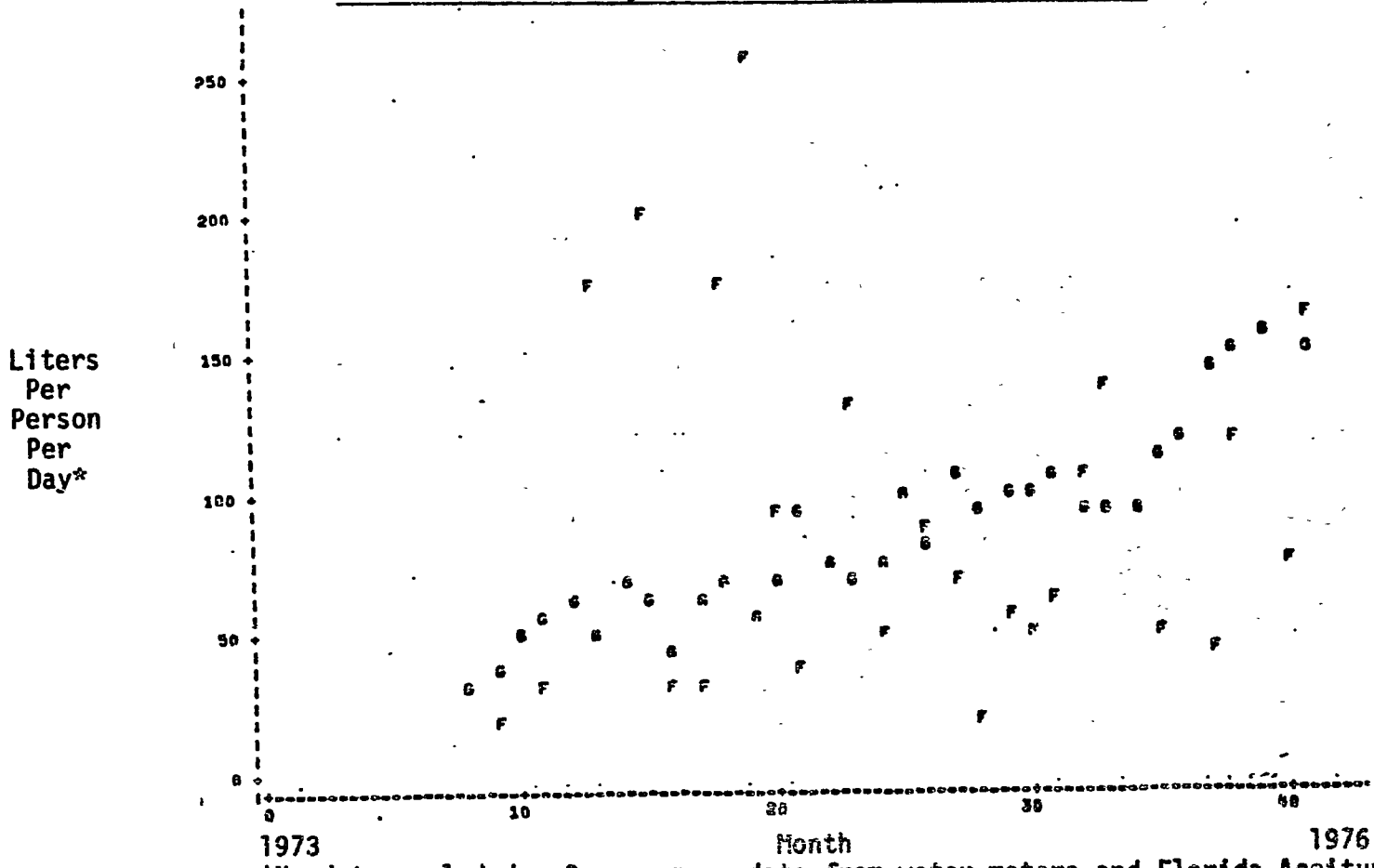
Legend: Monthly data points are the sample means from both villages.

Water Consumption in Guanagazapa and Florida Aceituno
by Month of Study



*Mean family consumption greater than 200 liters/person/day excluded.
Guanagazapa data from water meters and Florida Aceituno data by recall.
Monthly data points are the sample means from both villages.

Water Consumption in Guanagazapa and Florida Aceituno
by Month of Study



*No data excluded. Guanagazapa data from water meters and Florida Aceituno data by recall. Monthly data points are the sample means from both villages.

Mean Water Consumption per Day in Guanagazapa

WATCON[1]	FREQUENCY[2]	CUM FREQ	PERCENT	CUM PERCENT
.	4941	.	.	.
5	32	32	0.721	0.721
15	203	235	4.576	5.298
25	359	594	8.093	13.390
35	511	1105	11.519	24.910
45	442	1547	9.964	34.874
55	399	1946	8.995	43.868
65	386	2332	8.702	52.570
75	333	2665	7.507	60.077
85	250	2915	5.636	65.712
95	201	3116	4.531	70.243
105	192	3308	4.328	74.572
115	158	3466	3.562	78.133
125	154	3620	3.472	81.605
135	123	3743	2.773	84.378
145	75	3818	1.691	86.069
155	64	3882	1.443	87.511
165	56	3938	1.262	88.774
175	54	3992	1.217	89.991
185	49	4041	1.105	91.096
195	38	4079	0.857	91.952
205	357	4436	8.048	100.000

Mean Water Consumption per Day in Florida Aceituno

WATCON[1]	FREQUENCY[2]	CUM FREQ	PERCENT	CUM PERCENT
.	2857	.	.	.
5	232	232	31.565	31.565
15	234	466	31.837	63.401
25	77	543	10.476	73.878
35	37	580	5.034	78.912
45	27	607	3.673	82.585
55	28	635	3.810	86.395
65	22	657	2.993	89.388
75	12	669	1.633	91.020
85	12	681	1.633	92.653
95	9	690	1.224	93.878
105	10	700	1.361	95.238
115	12	712	1.633	96.871
125	3	715	0.408	97.279
135	2	717	0.272	97.551
145	4	721	0.544	98.095
165	3	724	0.408	98.503
175	1	725	0.136	98.639
195	1	726	0.136	98.776
205	9	735	1.224	100.000

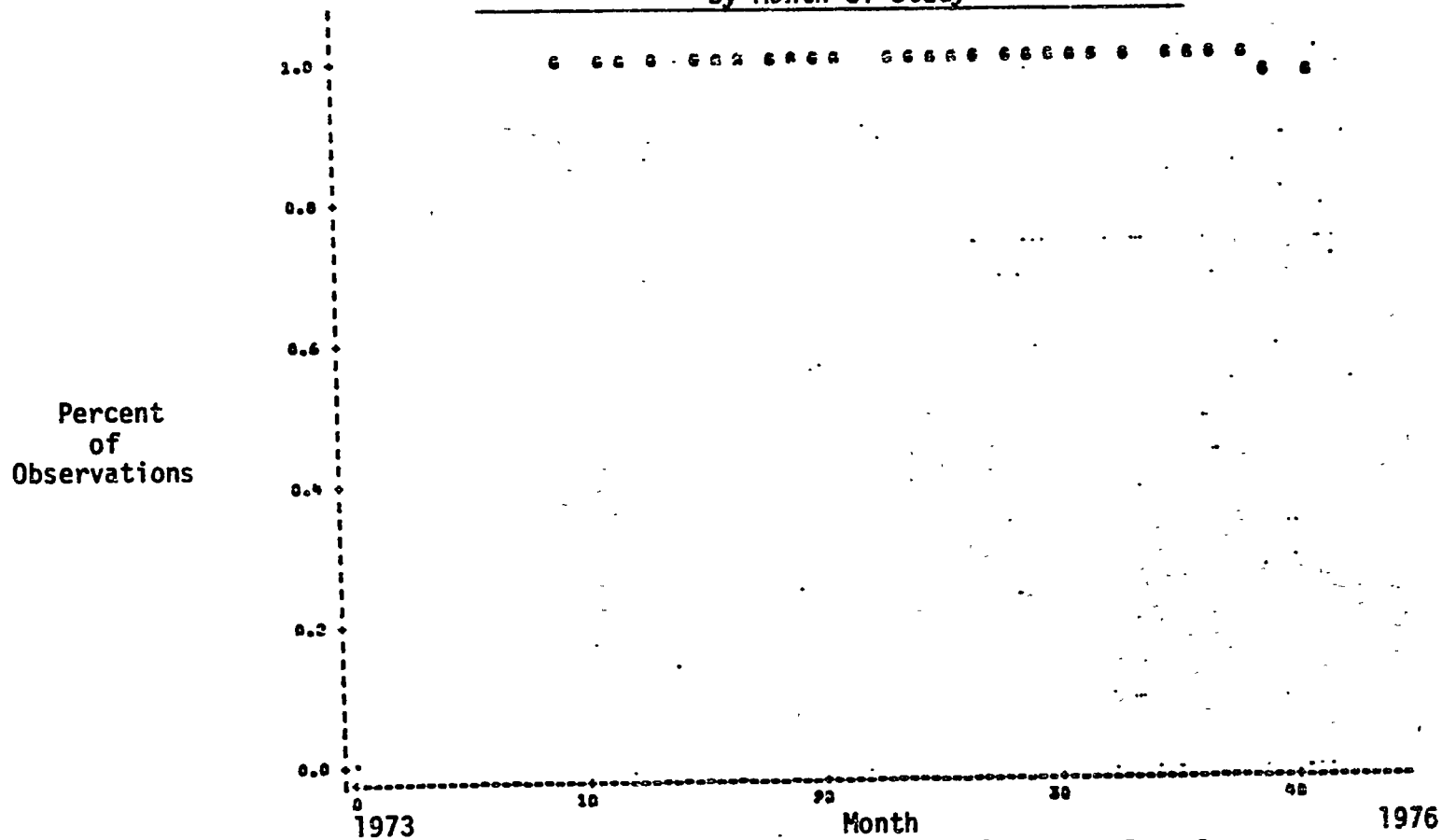
1. WATCON: Water consumption in liters/person/day.
2. Frequency: Number of Families.

Descriptive Statistics for Household Water Uses
(Both Villages Combined-Form 37)

LABEL	N	MEAN *	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
COMMUNITY ID NUMBER	2837	1.72154	0.4483	1.00000	2.000	0.008417
FAMILY IDENTIFICATION	2837	108.56468	64.6703	2.00000	352.000	1.214159
YEAR OF DATA COLLECTION	2837	74.77934	0.8535	73.00000	76.000	0.016024
MONTH OF DATA COLLECTION	2837	6.08315	3.4127	1.00000	12.000	0.064073
DAY OF DATA COLLECTION	1742	16.01435	8.0976	1.00000	31.000	0.194015
BLOCK NUMBER	2837	21.91435	10.2983	1.00000	40.000	0.193347
HOUSE NUMBER	2835	5.04621	5.2650	1.00000	39.000	0.098883
PERSONAL HYGIENE	1740	0.99138	0.0925	0.00000	1.000	0.002217
FOOD PREPARATION	1741	0.99770	0.0479	0.00000	1.000	0.001148
UTENSIL CLEANING	1740	0.96954	0.1719	0.00000	1.000	0.004121
LAUNDRY	1740	0.57414	0.4946	0.00000	1.000	0.011857
BATHING	1741	0.50390	0.5001	0.00000	1.000	0.011985
GIVEN TO OTHER HOUSES	1740	0.17586	0.3808	0.00000	1.000	0.009129
OTHER	1740	0.41437	0.4928	0.00000	1.000	0.011813
DAYS BETWEEN READINGS	2801	24.50375	21.3944	1.00000	176.000	0.404244
NUMBER OF INHABITANTS	2837	7.71343	3.9626	1.00000	19.000	0.074397
LITRES PER PERSON PER DAY	2837	85.93232	170.4904	1.00000	999.000	3.201038
CONSUMPTION IN LITRES PER DAY	930	132.98495	186.2036	3.00000	1470.000	6.105856
METER READING	1822	23253.48573	21149.9548	790.00000	177850.000	495.490415

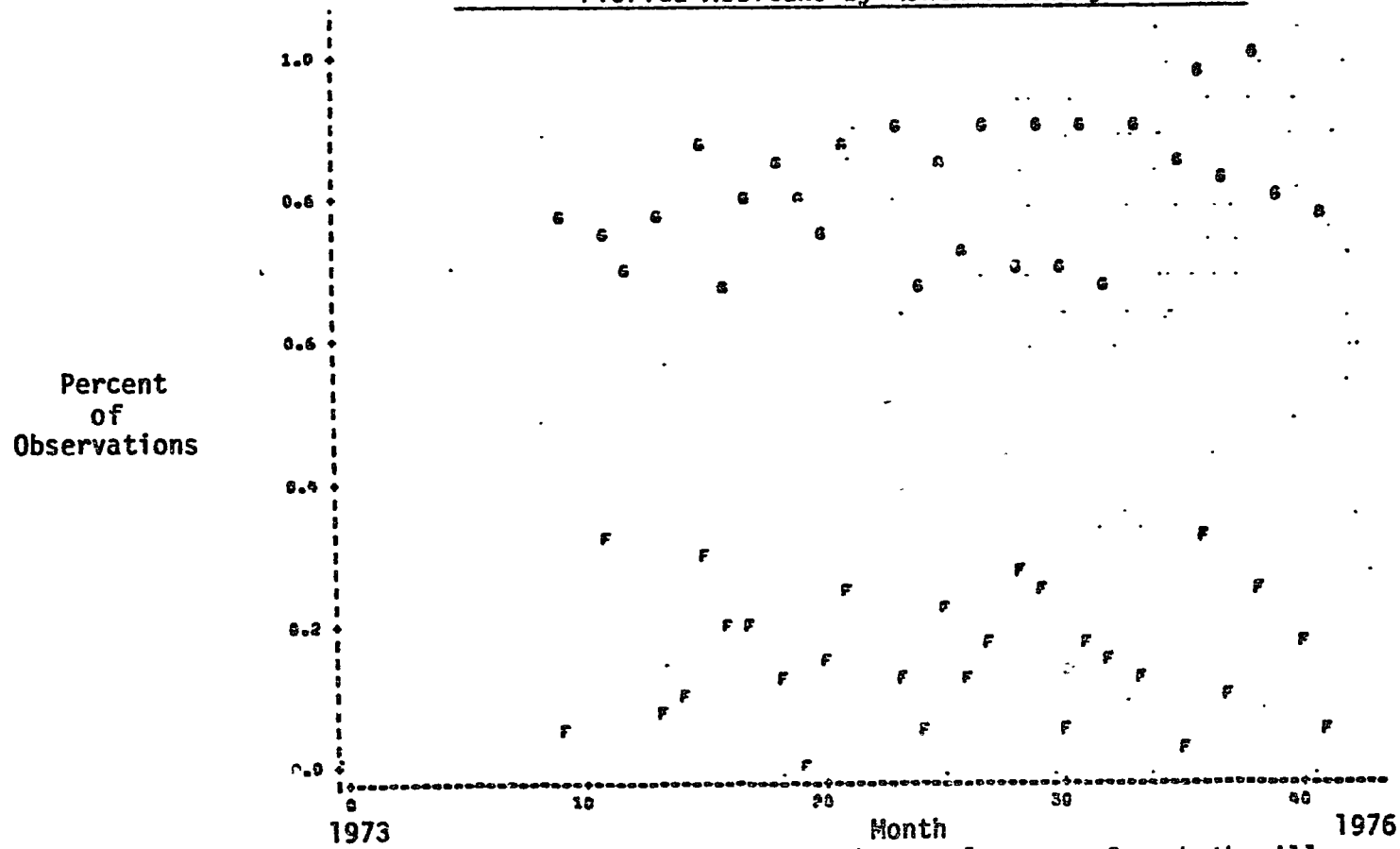
* Percent of observations when water was used for these purposes (Minimum value-water never used for this purpose, Maximum value-water always used for this purpose).

Water Used for Personal Hygiene in Guanagazapa
by Month of Study



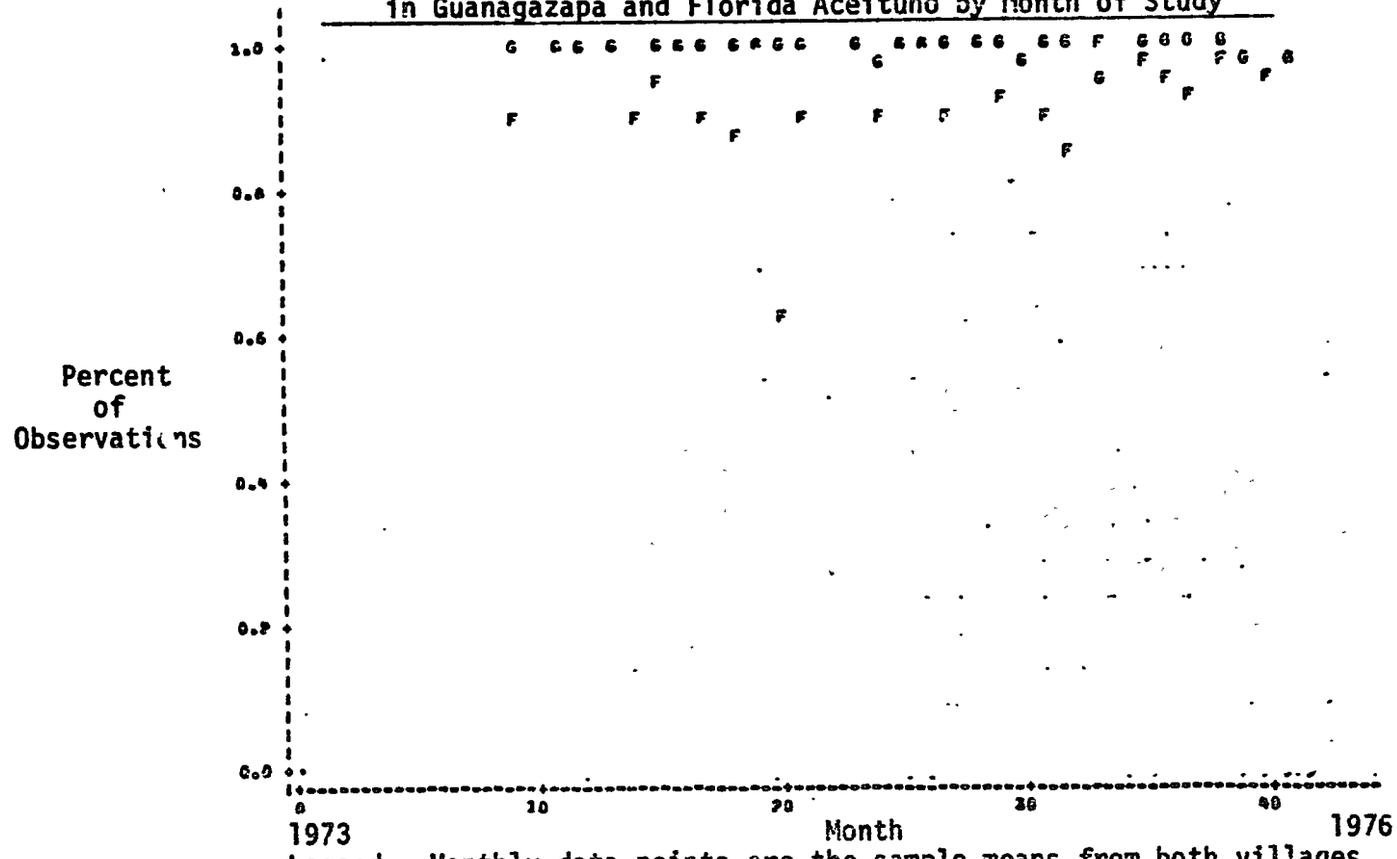
Legend: Monthly data points are the sample means from Guanagazapa.

Household Water Used for Bathing in Guanagazapa and Florida Aceituno by Month of Study



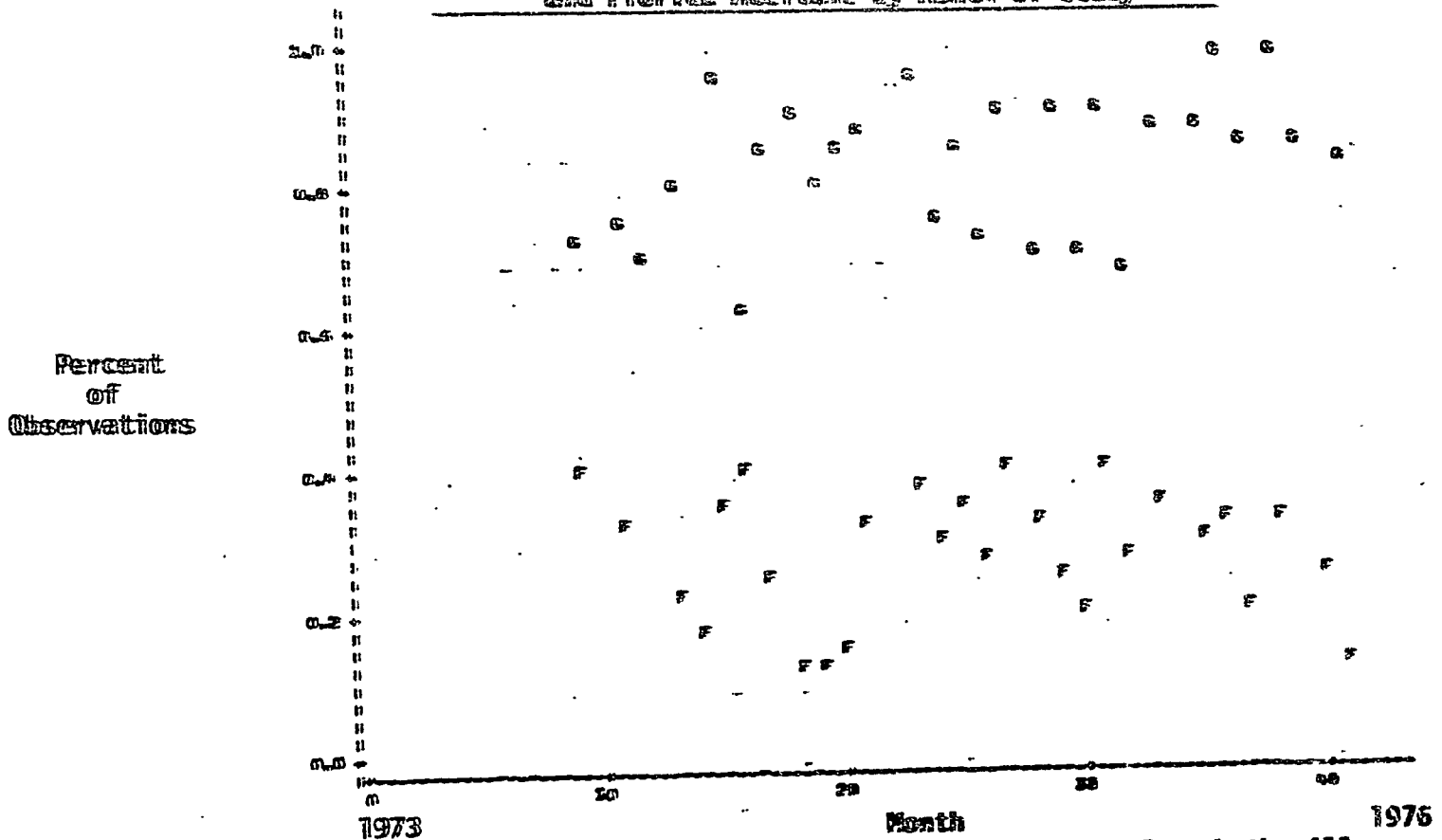
Legend: Monthly data points are the sample means from both villages.

Household Water Used for Washing Cooking and Eating Utensils in Guanagazapa and Florida Aceituno by Month of Study



Legend: Monthly data points are the sample means from both villages.

Household Water Used for Laundering in Quezaltepe and Florida Acaitumo by Month of Study



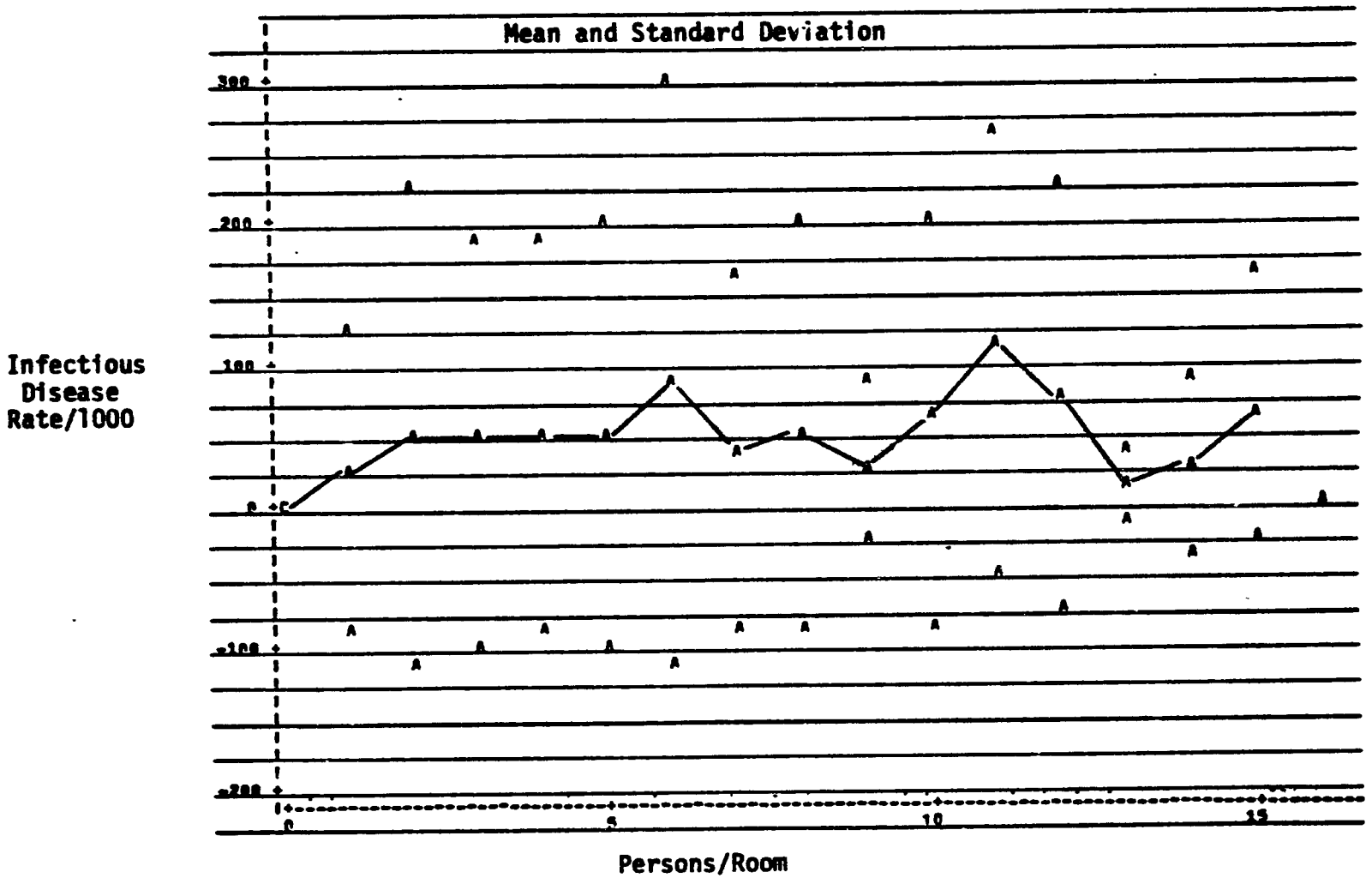
Legend: Monthly data points are the sample means from both villages.

Descriptive Statistics for Household Sanitation
(Both Villages Combined-Form 32)

LABEL	N	MEAN*	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
FAMILY IDENTIFICATION	5390	126.3473098	89.17785124	1.0000000	386.000000	1.21466207
COMMUNITY ID NUMBER	5390	1.5109462	0.49992654	1.0000000	2.000000	0.00680945
YEAR OF DATA COLLECTION	5390	74.7387755	0.95648463	73.0000000	76.000000	0.01302818
MONTH OF DATA COLLECTION	5390	6.2202226	2.97554614	1.0000000	11.000000	0.04052963
DAY OF DATA COLLECTION	5390	14.0473098	7.00657031	1.0000000	31.000000	0.09543575
BLOCK NUMBER	5390	19.3315399	10.33039767	1.0000000	40.000000	0.14070525
HOUSE NUMBER	5390	5.6176252	6.16304308	1.0000000	41.000000	0.08394616
FAMILY POSITION OF INFORMANT	5377	3.1515715	7.98307209	1.0000000	71.000000	0.10886795
SEX OF INFORMANT	5376	1.8539807	0.35368767	1.0000000	2.000000	0.00482377
IS INFORMANT WEARING SHOES	5354	0.5046694	0.50002489	0.0000000	1.000000	0.00683365
STATE OF INFORMANT'S CLOTHES	5366	1.0480805	0.66036721	0.0000000	2.000000	0.00901488
OBSERVATION ABOUT FAMILY	5297	0.9250519	0.60822366	0.0000000	2.000000	0.00835710
OBSERVATION ABOUT HOUSE	292	0.4726027	0.50016551	0.0000000	1.000000	0.02926648
KITCHEN - GARBAGE ON FLOOR	5179	0.6024329	0.48984229	0.0000000	1.000000	0.00680109
KITCHEN - FECAL MATL ON FLOOR	5176	0.4030139	0.49055050	0.0000000	1.000000	0.00681047
KITCHEN - BARRIER AGAINST ANIMALS	5178	0.0442256	0.20561574	0.0000000	1.000000	0.00285743
ANIMALS IN KITCHEN	5159	0.5603799	0.49635899	0.0000000	1.000000	0.00691658
COOKED FOOD IN KITCHEN	271	0.9372694	0.24292648	0.0000000	1.000000	0.01475673
COOKED FOOD COVERED	4368	0.5921165	0.49149354	0.0000000	1.000000	0.00719371
FLIES ON FOOD	4674	0.3690329	0.48260264	0.0000000	1.000000	0.00705904
PLATES PROTECTED FROM ANIMALS	644	0.9565217	0.20408966	0.0000000	1.000000	0.00804226
WATER CONTAINER COVERED	2977	0.6479759	0.78163757	0.0000000	2.000000	0.01235446
CUPS STORED MOUTH DOWN	292	0.8540099	0.35312034	0.0000000	1.000000	0.02102001
ANIMAL CONTROL CURRENT	228	0.0833333	0.27699351	0.0000000	1.000000	0.01834434
ANIMALS IN YARD	259	0.0733591	0.26122578	0.0000000	1.000000	0.01623203
GARBAGE OUTSIDE	5362	0.5561358	0.49686512	0.0000000	1.000000	0.00676567
GARBAGE BURNED	304	0.0230263	0.15023431	0.0000000	1.000000	0.00861653
YARD SWEPT	5353	0.4537602	0.49790417	0.0000000	1.000000	0.00680514
LATRINE CLEAN	1786	0.5705467	0.49513645	0.0000000	1.000000	0.01171013
FLIES IN LATRINE	96	0.1145833	0.32019046	0.0000000	1.000000	0.03267930
SOAP OBSERVED	278	0.4838115	0.50069427	0.0000000	1.000000	0.03002565
WASH HANDS BEFORE COOKING	2	1.0000000	0.00000000	1.0000000	1.000000	0.00000000
CONDITION OF WELL	65	1.3076923	0.91724922	0.0000000	2.000000	0.11377077
WELL BUCKET ON GROUND	61	0.1147541	0.32137022	0.0000000	1.000000	0.04114721
EXCREMENT IN CHILDREN'S DIAPERS	1730	3.8416185	0.74362107	1.0000000	6.000000	0.01788321
SURVEYED ID NUMBER	5389	17.7270366	6.21130721	0.0000000	64.000000	0.08460868

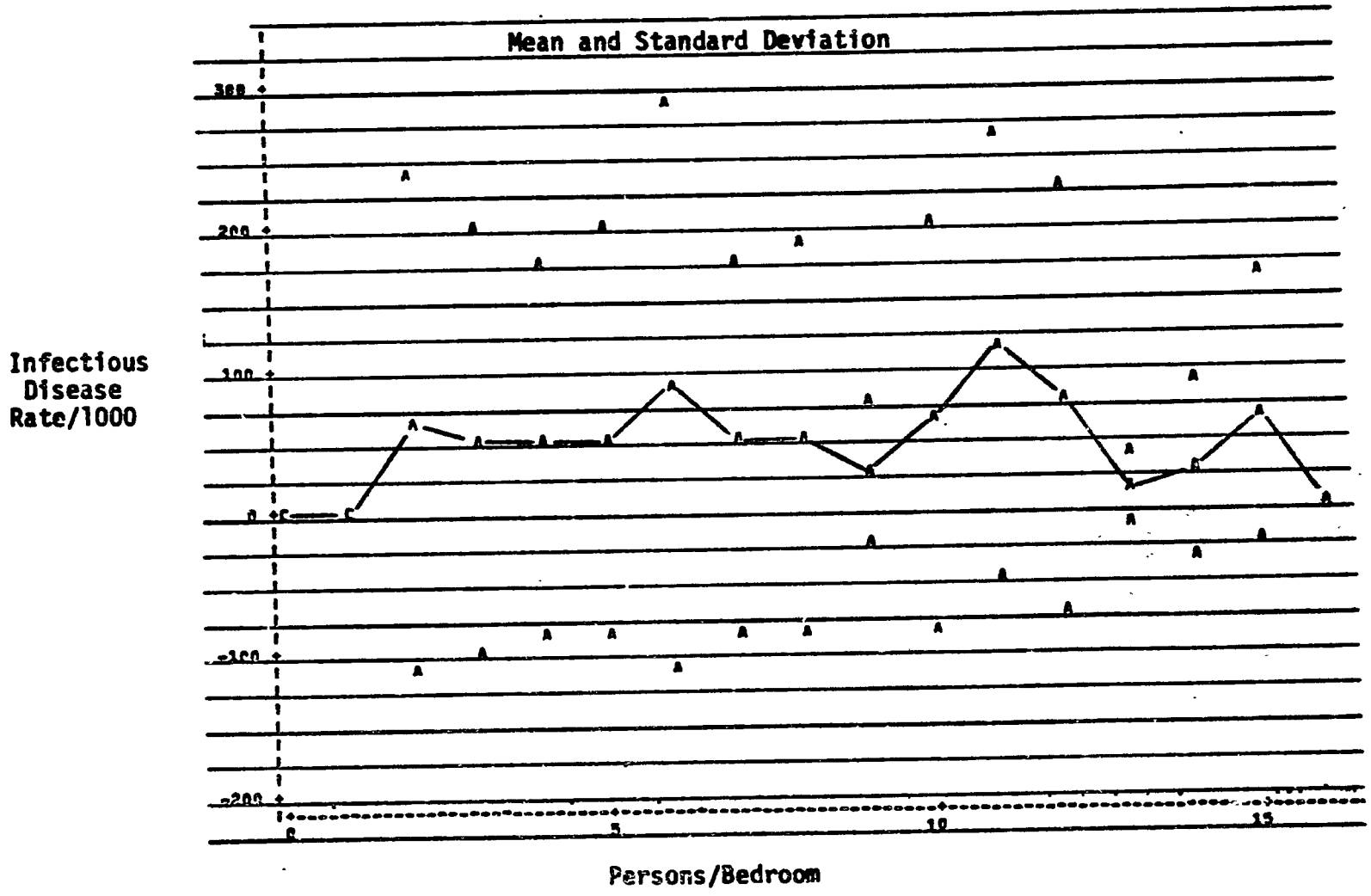
*Percent of satisfactory observations (Minimum value-0% satisfactory, Maximum value-100% satisfactory).

Infectious Disease Morbidity Rate Versus Total Room Crowding Index
(Guanagazapa)



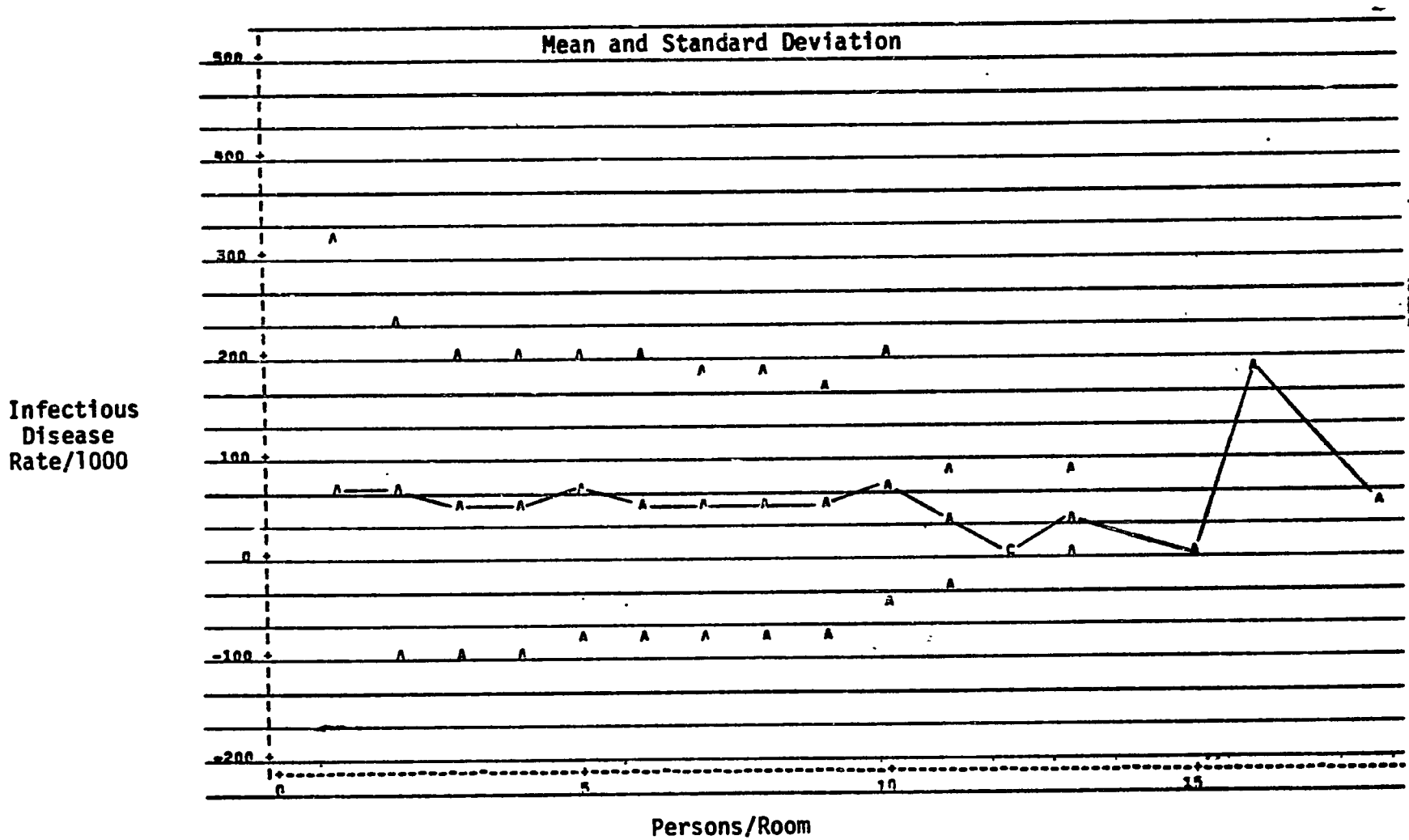
Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded to nearest whole integer.
Infectious disease: otitis and conjunctivitis.

Infectious Disease Morbidity Rate Versus Bedroom Crowding Index
(Guanagazapa)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/Bedroom: rounded to nearest whole integer.
Infectious disease: otitis, conjunctivitis.

Infectious Disease Morbidity Rate Versus Total Room Crowding Index
(Florida Aceituno)



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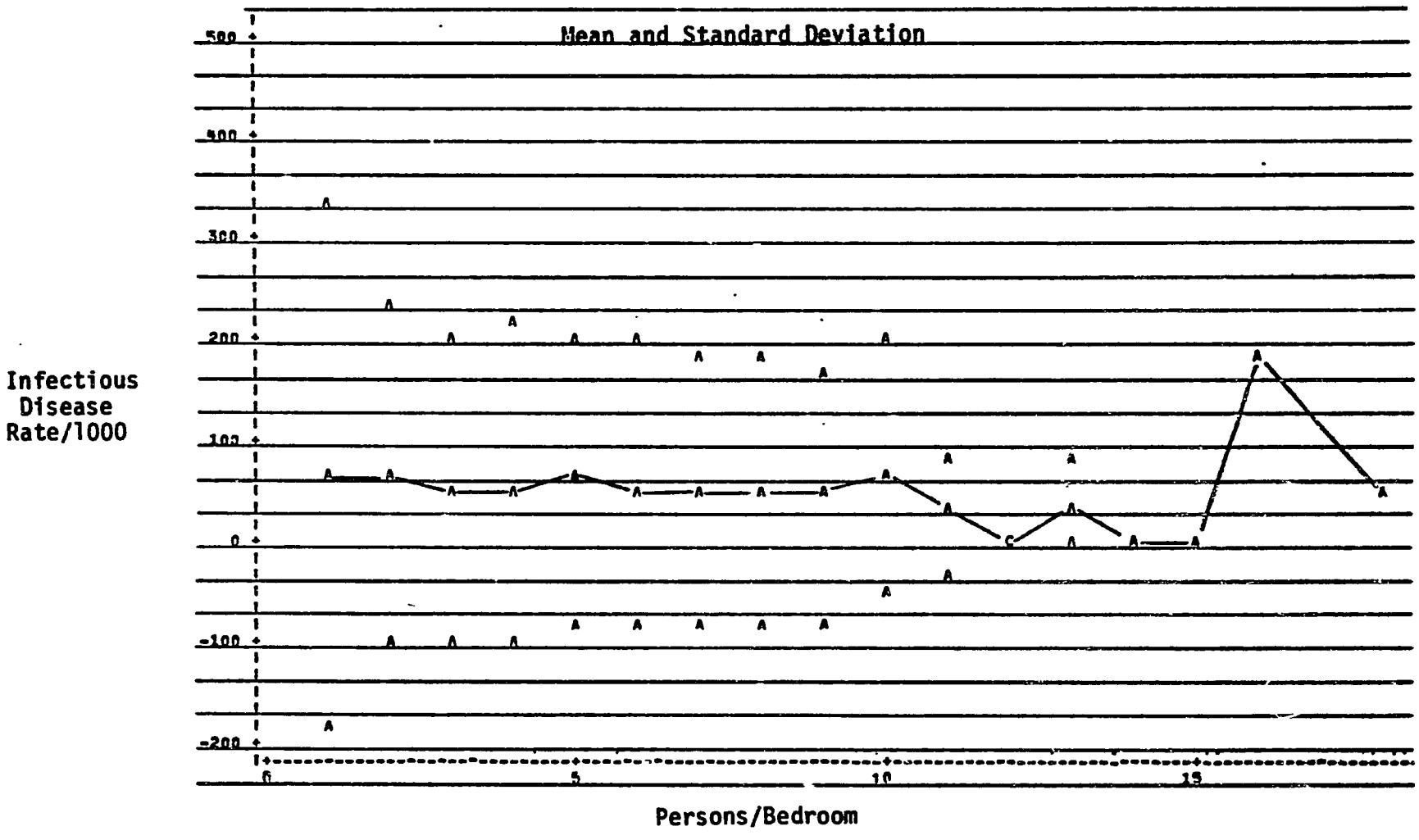
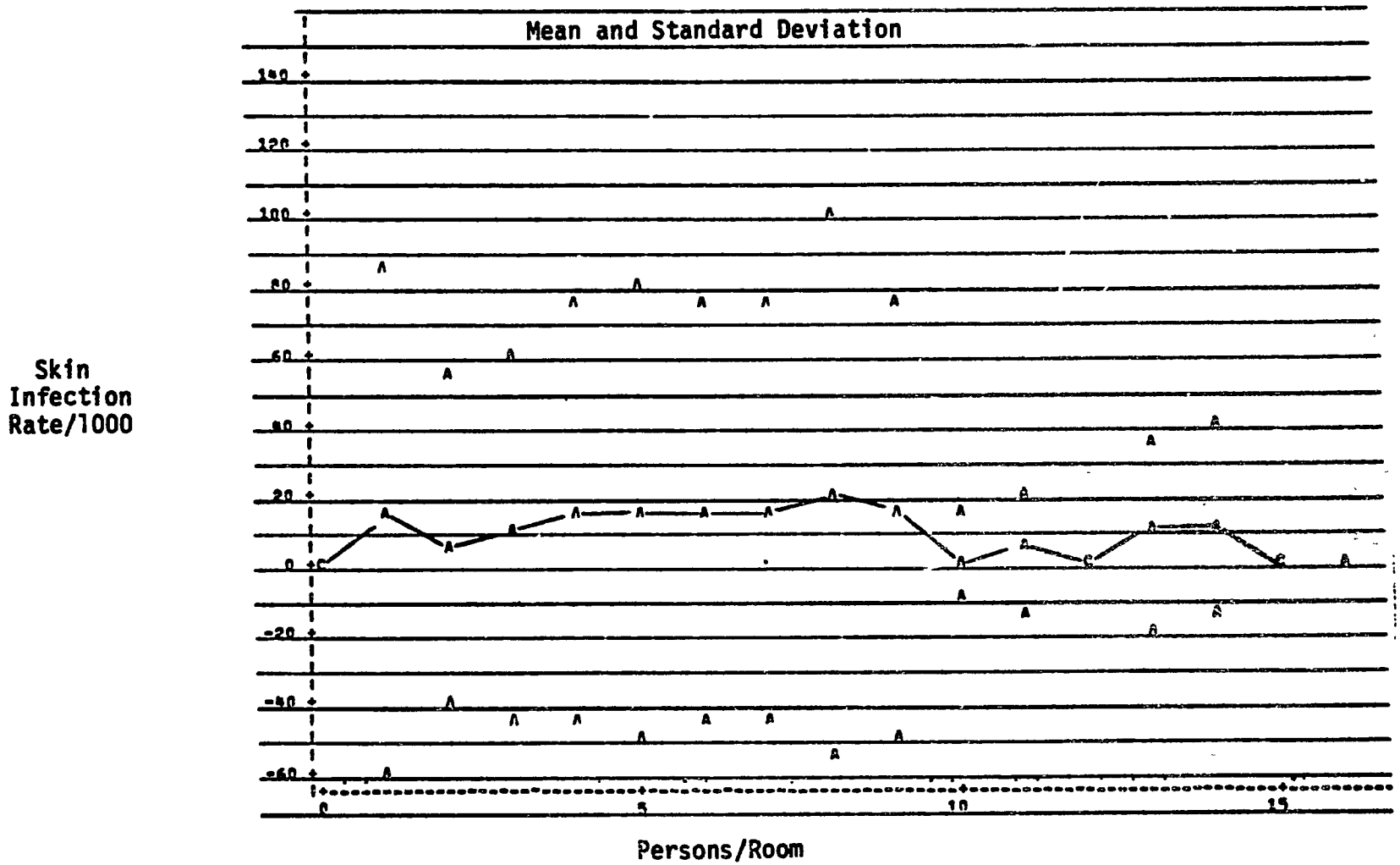
Persons/room: rounded to nearest whole integer.
Infectious disease: otitis and conjunctivitis.

Infectious Disease Morbidity Rate Versus Bedroom Crowding Index
(Florida Aceituno)



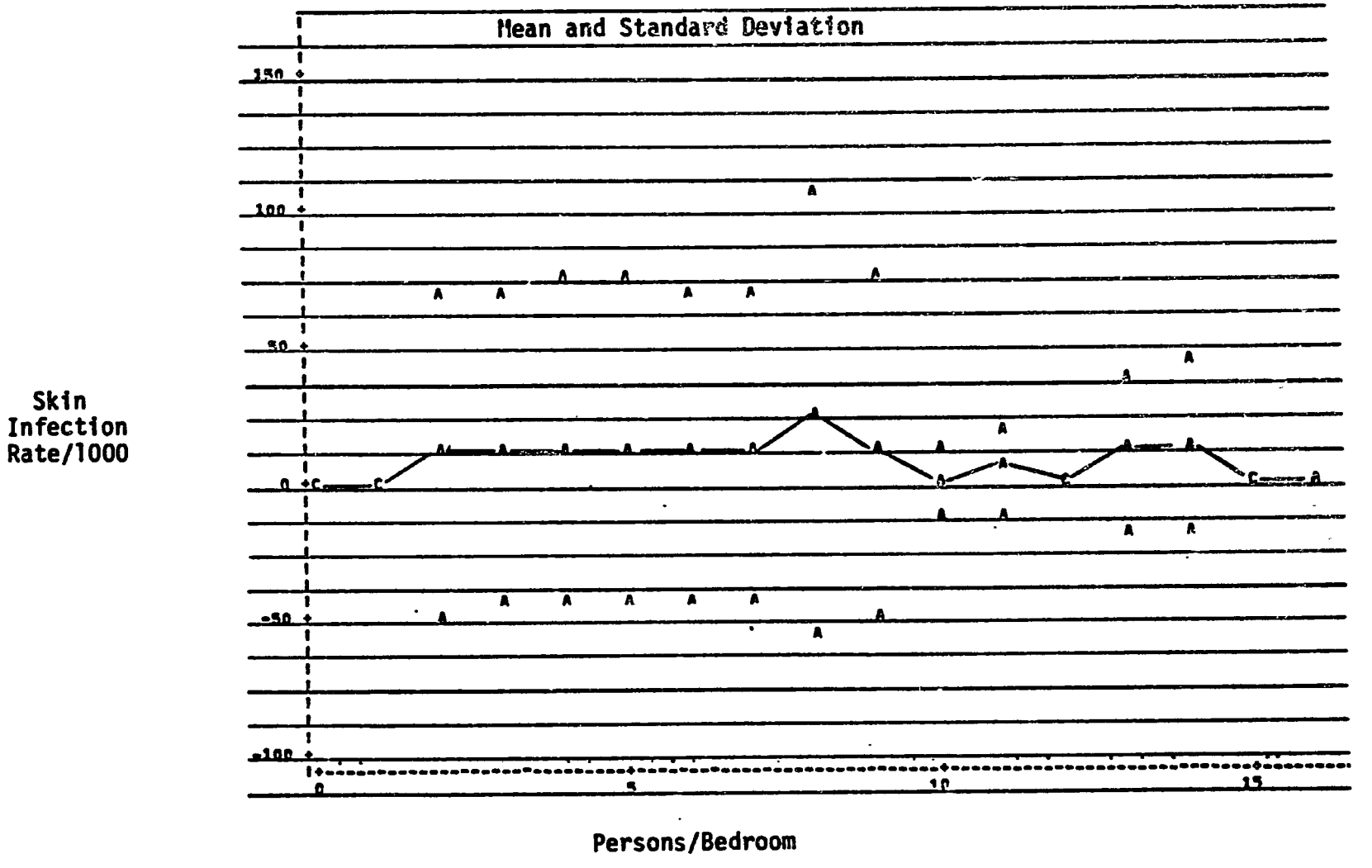
Legend: A= 1 observation, B= 2 observations, etc.
Persons/bedroom: rounded to nearest whole integer.
Infectious Disease: Otitis and conjunctivitis.

Skin Infection Morbidity Rate Versus Total Room Crowding Index
(Guanagazapa)



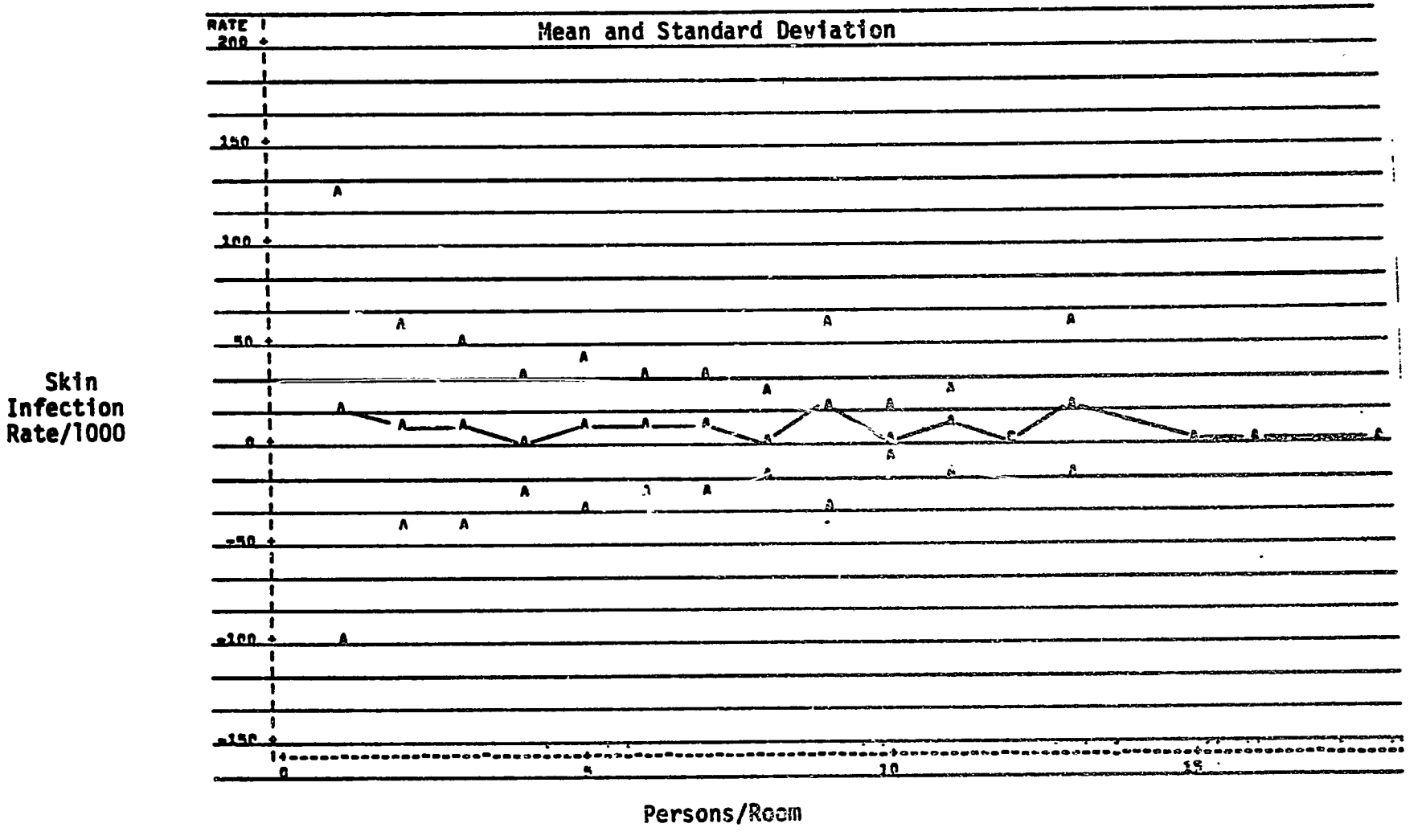
Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded to nearest whole integer.

Skin Infection Morbidity Rate Versus Bedroom Crowding Index
(Guanagazapa)



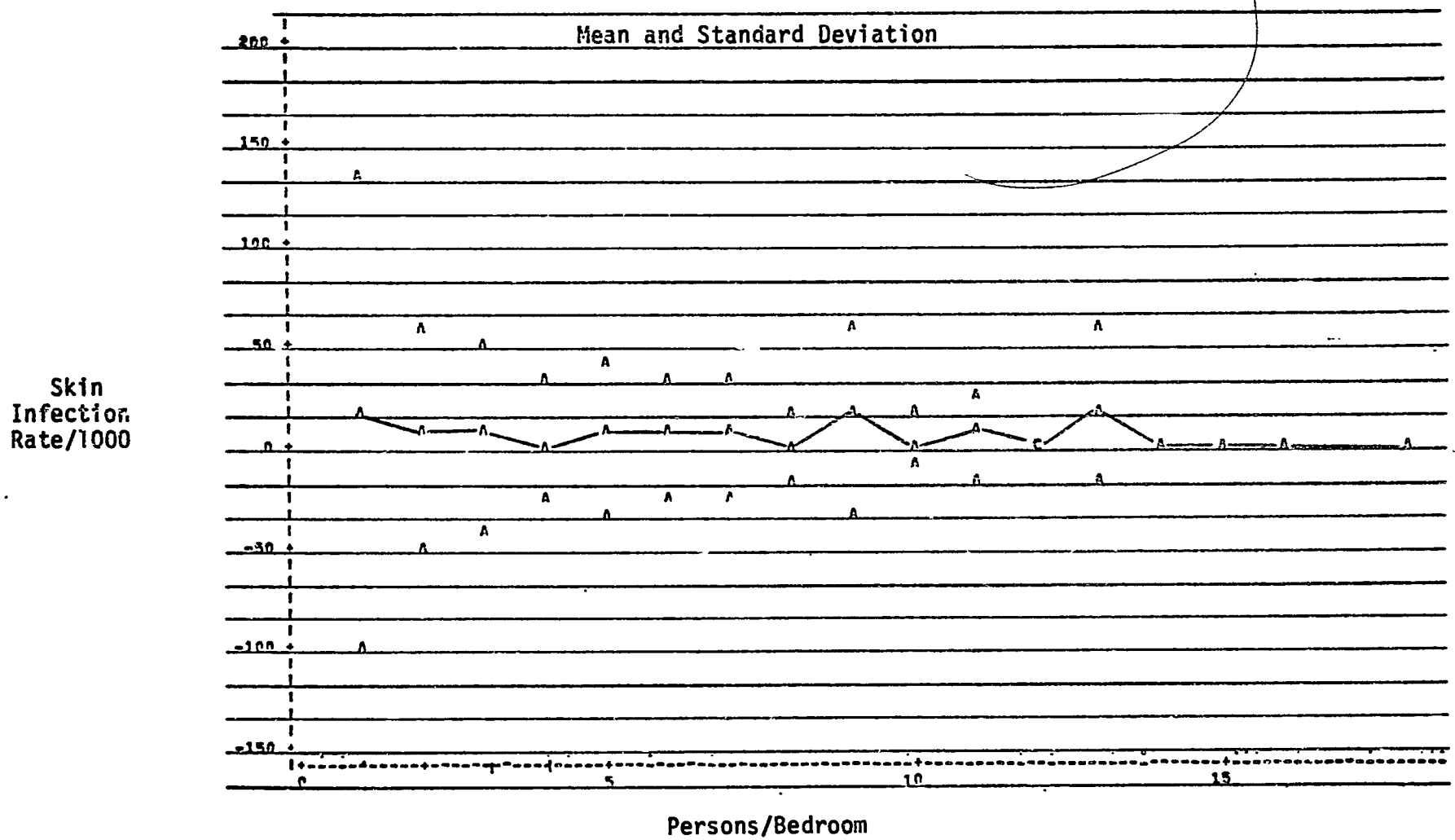
Legend: A= 1 observation, B= 2 observations, etc.
Persons/Bedroom: rounded to nearest whole integer.

Skin Infection Morbidity Rate Versus Total Room Crowding Index
(Florida Aceituno)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/room: rounded to nearest whole integer.

Skin Infection Morbidity Rate Versus Bedroom Crowding Index
(Florida Aceituno)



Legend: A= 1 observation, B= 2 observations, etc.
Persons/bedroom: rounded to nearest whole integer.