PN-ABE-205

THE COLLABORATIVE RESEARCH SUPPORT PROGRAM ON FOOD INTAKE AND HUMAN FUNCTION

EGYPT REPORT

FINAL REPORT

Submitted to the United States Agency for International Development
Grant # DAN-1309-G-SS-1070-00

15 November 1987

Nutrition Institute
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APPENDIX TO FINAL REPORT

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PREFACE

Due to time pressures to submit the final report of the Egypt Project to the Management Entity and USAID in a timely manner, a temporary procedure was used for the energy analyses of food intake data of the Egypt Project. This procedure became necessary after some errors in the food composition database were detected in the final stages of preparation of the final report. In order to expedite the completion of the report, all data for dietary energy intake were recalculated with the use of the Atwater factors for energy. These data are included in the final report dated 15 November 1987.

Since the submission of the final report, the food composition database for the Eygpt Project has been corrected and all food intake data as well as analyses which used food intake data have been reanalyzed with the use of the corrected database. This appendix contains certain tables, figures and text that were changed, albeit in most cases only slightly, by reanalyses of the food intake data.

Page numbers used in the appendix refer to pages of the final report (dated 15 November 1987) in which changes have been made. Due to differences in type size and page breaks in the appendix compared to the final report some pages in the appendix have two numbers.

Table 5.12. Median toddler food intake (non-breast-milk) Kcal/day

Age in Months	Males		Females	
	Weaned	Not Yet Weaned	Weaned	Not Yet Weaned
18	902 (21)**	739 (42)	904 (27)	744 (26)
19	910 (25)	742 (32)	914 (25)	777 (26)
20	1036 (29)	819 (25)	888 (29)	966 (18)
21	956 (32)	759 (20)	1058 (37)	809 (14)
22	1052 (42)	911 (16)	1040 (44)	810 (8)
23	1008 (47)	992 (9)	1087 (47)	912 (5)
24	1190 (47)	788 (9)	1079 (48)	660 (1)
25	987 (54)	1047 (4)	1060 (43)	891 (2)
26	1025 (53)	960 (4)	1315 (49)	
27	1025 (55)	1768 (1)	1028 (48)	
28	1118 (49)	927 (1)	1076 (49)	
29	1087 (50)		1083 (47)	

**(N)

Table 5.13 Median toddler food intake (non-breast milk), Kcal/Kg/day*

Age in Months	Males		Females	
	Weaned	Not Yet Weaned	Weaned	Not Yet Weaned
18	84 (16)	68 (36)	96 (24)	78 (21)
19	91 (21)	66 (27)	91 (22)	79 (21)
20	100 (22)	80 (22)	99 (26)	106 (14)
21	91 (26)	67 (17)	113 (29)	82 (12)
22	95 (34)	72 (15)	109 (36)	79 (6)
23	89 (38)	81 (9)	101 (37)	95 (3)
24	103 (40)	79 (8)	97 (36)	64 (1)
25	83 (48)	110 (3)	101 (36)	82 (2)
26	88 (45)	99 (3)	112 (37)	
27	89 (48)	177 (1)	94 (39)	
28	87 (43)	90 (1)	90 (41)	
29	85 (42)		92 (40)	

*Estimated weight based on regression of weight on age for each subject

Table 5.14.
Energy intake of toddlers by age; least-square means, adjusted for individual effect and breast-feeding status

Age in Months	Kcal	(SE)	Kcal/Kg*	(SE)
18	824	(31)	82	(3)
19	882	(32)	89	(3)
20	958	(33)	97	(3)
21	929	(34)	93	(3)
22	1025	(34)	99	(3)
23	1032	(35)	96	(3)
24	1054	(36)	96	(4)
25	1006	(37)	90	(4)
26	1125	(37)	98	(4)
27	1056	(38)	92	(4)
28	1044	(39)	87	(4)
29	1076	(39)	86	(4)

*Estimated weight based on regression of weight on age for each subject

Table 5.15.
Bivariate correlations between key variables over the entire study period (sexes combined)

Variables	Correlation Coefficient (r)+
Average Kcal/Kg vs Intercept of Weight Regressed on Age	-.52
Average Kcal/Kg vs Average Weight Z-score	-.49
Average Kcal/Kg vs Average Weight	-.53
Average Kcal/Kg vs Average Height Z-score	-.36
Average Kcal/Kg vs Average Height	-.39
Average Kcal/Kg vs Average Wt/Ht Z-scores	-.38
Average Kcal/Kg vs Average Weight/Height	-.48
Average Kcal/Kg vs Socioeconomic Status	-.11 ns
Growth* vs Average Kcal/Kg	-.09 ns
Growth vs Percent of Days Sick	.10 ns
Growth vs Percent of Days with Diarrhea	.04 ns
Growth vs Household Size**	.24
Growth vs Socioeconomic Status	.01 ns
Sanitation/Hygiene Score vs Average Height Z-Scores	.32
Sanitation/Hygiene vs Average Weight Z-score	.16
Sanitation/Hygiene vs Socioeconomic Status	-.35
Sanitation/Hygiene vs Household Size*	-.22
Percent of Days Sick with SES	.06 ns
Percent of Days Sick with Sanitation/Hygiene	-.05 ns
Percent of Days Sick with Household Size	-.03 ns
Percent of Days Sick with Average Kcal/Kg	-.06 ns

+All coefficients shown are significant at $p < .05$. Those in boldface are significant at $p < .001$.
*Slope of the line regressing weight on age
**Square root of number of persons in the household

Table 5.18 continued

II. With Food Intake (575 observations)

Variable	df	Type I Sums of Squares	F	p
Sex	1	64.6	172.2	<.0001
ID(Sex)	126	1000.5	21.2	<.0001
Linear Effect of Age	1	243.6	650.3	<.0001
Month of the Year	11	30.6	7.4	<.0001
Breast-feeding Status (yes, no)	1	2.1	5.7	<.05
Sex vs. Breast-feeding Interaction	1	0.4	0.95	ns
Kcalories/day in Previous Month	1	0.6	1.5	ns

R^2 = .89
Root Mean Square Error = .61
Coefficient of Variation = 5.5%

Parameter Estimates (þ SE of Estimate):
Linear Effect of Age: .23 þ .01 kg
Kcal/day in Previous Month: 0.0001 þ .0001 kg

III. With Food Intake and Percent of Days with Diarrhea in Previous Month (551 observations)

Variable	df	Type I Sums of Squares	F	p
Sex	1	52.2	159.5	<.0001
ID(Sex)	122	970.9	24.3	<.0001
Linear Effect of Age	1	239.9	732.5	<.0001
Month of the Year	11	25.5	7.1	<.0001
Breast-feeding Status (yes, no)	1	2.6	8.0	<.01
Sex vs. Breast-feeding Interaction	1	0.3	1.0	ns
Kcalories/day in Previous Month	1	0.7	2.2	ns
Percent of Days in Previous with Diarrhea	1	0.7	2.0	ns

R^2 = .90
Root Mean Square Error = .57
Coefficient of Variation = 5.1%
Parameter Estimates (þ SE of Estimate):
Linear Effect of Age: .24 þ .01 kg
Kcal/day in Previous Month: .0001 þ .0001 kg
Diarrhea in Previous Month: -.37 þ .26 kg

Table 5.31. Energy and protein intakes of pregnant and lactating women (longitudinal data)

	Kcal per day	Kcal per Kg body weight[a]	Total protein % of Kcal	Total protein g/d	Animal protein g/d	Plant protein g/d
Pregnancy, trimester						
2	1965 ± 445[b,e,f] (1991)[c] 967 - 3109[d]	31.9 ± 8.9[e,f] (31.0) 16 - 57	12.9 ± 1.7[e,f] (13.0) 10 - 19	63.0 ± 15.2[e,f] (60.0) 32 - 111	21.5 ± 12.7[e,f] (19.0) 0 - 58	41.5 ± 9.6[e] (41.0) 20 - 65
3	1924 ± 399[e] (1928) 895 - 2660	29.8 ± 7.5[e] (29.0) 14 - 49	12.4 ± 1.7[e] (12.0) 7 - 16	60.3 ± 15.7[e] (60.0) 23 - 96	19.1 ± 10.9[e] (18.0) 0 - 49	41.3 ± 10.9[e] (40.0) 19 - 75
2 & 3	1948 ± 381 (1938) 1019 - 2988	30.8 ± 7.6 (29.0) 17 - 54	12.7 ± 1.2 (13.0) 11 - 16	62.0 ± 13.6 (61.0) 37 - 108	20.5 ± 9.7 (18.0) 2 - 55	41.4 ± 8.7 (40.0) 21 - 58
Lactation, mo						
0-3	2083 ± 378[f] (2096) 1244 - 2885	34.4 ± 8.5[f] (33.0) 16 - 54	13.1 ± 2.7[f] (12.0) 10 - 28	67.9 ± 16.8[g] (66.0) 32 - 128	24.2 ± 17.5[f] (21.0) 0 - 108	43.7 ± 11.1[e,f] (44.0) 11 - 69
3-6	2053 ± 326[f] (2007) 1246 - 2778	33.7 ± 7.4[f] (33.0) 19 - 51	12.7 ± 1.4[e,f] (13.0) 10 - 17	65.2 ± 12.5[f,g] (64.0) 35 - 96	20.3 ± 9.7[e,f] (19.0) 6 - 47	45.1 ± 8.2[f] (44.0) 25 - 66
0-6	2089 ± 257 (2060) 1522 - 2724	34.7 ± 7.2 (33.0) 20 - 58	12.9 ± 1.4 (13.0) 10 - 19	67.1 ± 10.5 (65.0) 44 - 100	22.1 ± 9.8 (21.0) 6 - 59	45.1 ± 7.1 (44.0) 32 - 68

[a]n=62-75; all other columns n=79
[b]Mean ± SD
[c]Median
[d]Range
[e-g]Means in columns with different superscripts differ significantly ($p<0.05$).

Table 5.32. Frequency distribution of energy intake and percent of energy intake as protein during pregnancy and lactation (longitudinal data)

	Kcal/d					
	≤1000	1000-1499	1500-1999	2000-2499	2500-2999	>3000
Pregnancy, trimester			% of women[a]			
2	1.3	13.9	38.0	35.4	8.9	2.5
	(1)[b]	(11)	(30)	(28)	(7)	(2)
3	1.3	12.7	40.5	39.2	6.3	0
	(1)	(10)	(32)	(31)	(5)	(0)
2 & 3	1.2	11.4	41.8	40.5	6.3	0
	(1)	(9)	(33)	(32)	(5)	(0)
Lactation, mo						
0-3	0	6.3	31.6	48.1	13.9	0
	(0)	(5)	(25)	(38)	(11)	(0)
3-6	0	3.8	45.6	44.3	6.3	0
	(0)	(3)	(36)	(35)	(5)	(0)
0-6	0	0	38.0	54.4	7.6	0
	(0)	(0)	(30)	(43)	(6)	(0)

	Kcal/Kg body weight				
	<20	20-29.9	30-39.9	40-49.9	>50
Pregnancy, trimester			% of women[c]		
2	6.8	34.2	39.7	15.1	4.1
	(5)	(25)	(29)	(11)	(3)
3	7.7	46.1	36.9	9.2	0
	(5)	(30)	(24)	(6)	(0)
2 & 3	5.3	45.3	34.6	13.3	0
	(4)	(34)	(26)	(10)	(0)
Lactation, mo					
0-3	1.5	26.5	44.1	22.1	5.9
	(1)	(18)	(30)	(15)	(4)
3-6	1.6	33.9	38.7	24.2	1.6
	(1)	(21)	(24)	(15)	(1)
0-6	0	22.7	54.7	20.0	2.7
	(0)	(17)	(41)	(15)	(2)

	Total protein, % of Kcal				
	<12	12-13.9	14-15.9	16-17.9	>18
Pregnancy, trimester			% of women[a]		
2	19.0	48.1	27.8	2.5	2.5
	(15)	(38)	(22)	(2)	(2)
3	26.6	49.4	16.5	7.6	0
	(21)	(39)	(13)	(6)	(0)
2 & 3	13.9	63.3	21.5	1.3	0
	(11)	(50)	(17)	(1)	(0)
Lactation, mo					
0-3	15.2	54.4	20.3	7.6	2.5
	(12)	(43)	(16)	(6)	(2)
3-6	20.3	60.8	13.9	5.1	0
	(16)	(48)	(11)	(4)	(0)
0-6	8.9	62.0	25.3	2.5	1.3
	(7)	(49)	(20)	(2)	(1)

[a]n=82; [b]Number of subjects; [c]n=68-82

Table 5.33. Frequency distribution of total, animal, and plant protein intakes during pregnancy and lactation (longitudinal data)

	Total protein, g/d				
	20-39	40-59	60-79	80-99	>100
	% of women[a]				
Pregnancy, trimester					
2	7.6	41.8	34.2	15.2	1.3
	(6)[b]	(33)	(27)	(12)	(1)
3	10.1	38.0	44.3	7.6	0
	(8)	(30)	(35)	(6)	(0)
2 & 3	3.8	39.2	45.6	10.1	1.3
	(3)	(31)	(36)	(8)	(1)
Lactation, mo					
0-3	2.5	32.9	44.3	15.2	5.1
	(2)	(26)	(35)	(12)	(4)
3-6	1.3	30.4	51.9	16.5	0
	(1)	(24)	(41)	(13)	(0)
0-6	0	21.5	65.8	11.4	1.3
	(0)	(17)	(52)	(9)	(1)

	Animal protein, g/d			
	<10	10-29	30-49	>50
	% of women[a]			
Pregnancy, trimester				
2	16.5	58.2	24.1	1.3
	(13)	(46)	(19)	(1)
3	16.5	65.8	17.7	0
	(13)	(52)	(14)	(0)
2 & 3	7.6	72.2	19.0	1.3
	(6)	(57)	(15)	(1)
Lactation, mo				
0-3	15.2	57.0	22.8	5.1
	(12)	(45)	(18)	(4)
3-6	1[illegible].7	70.9	16.5	0
	([illegible]0)	(56)	(13)	(0)
0-6	5.1	74.7	17.7	2.5
	(4)	(59)	(14)	(2)

	Plant protein, g/d				
	10-19	20-29	30-39	40-49	>50
	% of women[a]				
Pregnancy, trimester					
2	0	11.4	31.6	36.7	20.3
	(0)	(9)	(25)	(29)	(16)
3	1.3	8.9	38.0	26.6	25.3
	(1)	(7)	(30)	(21)	(20)
2 & 3	0	10.1	38.0	32.9	19.0
	(0)	(8)	(30)	(26)	(15)
Lactation, mo					
0-3	1.3	6.3	21.5	45.6	25.3
	(1)	(5)	(17)	(36)	(20)
3-6	0	1.3	22.8	44.3	31.6
	(0)	(1)	(18)	(35)	(25)
0-6	0	0	25.3	46.8	27.8
	(0)	(0)	(20)	(37)	(22)

[a]n=82; [b]Number of subjects

Table 5.34. Energy intake and percent of energy intake as protein for pregnant and lactating women classified by household socioeconomic status (longitudinal data)

	Household socioeconomic status			
	High	Upper Intermediate	Lower Intermediate	Low
	n=15	n=12	n=30	n=22
		Kcal/d		
Pregnancy, trimester				
2	1992 ± 537[a] (2010)[b]	1873 ± 346 (1960)	2021 ± 453 (2030)	1921 ± 432 (1865)
3	1766 ± 409 (1824)	1850 ± 296 (1857)	1914 ± 394 (1934)	2087 ± 411 (2102)
2 & 3	1869 ± 448 (1838)	1830 ± 237 (1789)	1989 ± 393 (2015)	2011 ± 378 (1988)
Lactation, mo				
0-3	2048 ± 280 (2136)	2021 ± 444 (2014)	2103 ± 414 (2098)	2113 ± 366 (2110)
3-6	2069 ± 330 (2007)	2142 ± 276 (2249)	2012 ± 312 (1979)	2050 ± 374 (2000)
0-6	2095 ± 172 (2092)	2106 ± 251 (2115)	2083 ± 260 (2047)	2085 ± 316 (2012)
		Kcal/Kg body weight[c]		
Pregnancy, trimester				
2	33.9 ± 13.4 (29)	32.4 ± 6.5 (33)	31.5 ± 8.4 (31)	31.0 ± 7.4 (31)
3	27.7 ± 9.0 (26)	29.8 ± 5.3 (28)	29.2 ± 8.5 (29)	32.1 ± 6.1 (31)
2 & 3	31.5 ± 11.3 (31)	30.6 ± 4.6 (28)	29.9 ± 7.7 (29)	31.6 ± 5.7 (30)
Lactation, mo				
0-3	35.1 ± 7.9 (34)	36.3 ± 8.9 (36)	32.5 ± 9.8 (31)	34.9 ± 7.3 (32)
3-6	32.3 ± 7.1[d] (31)	38.3 ± 4.8[e] (40)	32.7 ± 8.1[d] (33)	33.2 ± 7.1[d] (31)
0-6	35.9 ± 8.6[d,e] (35)	37.6 ± 4.9[d] (37)	32.9 ± 7.6[e] (32)	34.6 ± 6.4[d,e] (32)
		Total protein, % of Kcal		
Pregnancy, trimester				
2	13.7 ± 1.9 (14)	12.7 ± 1.6 (12.5)	12.9 ± 1.7 (13)	12.6 ± 1.3 (12.5)
3	12.9 ± 1.8[d] (13)	12.7 ± 1.9[d] (12)	12.7 ± 1.7[d] (12.5)	11.6 ± 1.6[e] (12)
2 & 3	13.4 ± 1.5[d] (13)	12.7 ± 1.2[d,e] (12)	12.8 ± 1.1[d,e] (13)	12.3 ± 1.0[e] (12)
Lactation, mo				
0-3	13.1 ± 1.4 (13)	12.6 ± 1.8 (12.5)	13.4 ± 2.7 (12.5)	13.0 ± 3.6 (12)
3-6	12.9 ± 1.9 (13)	13.1 ± 1.9 (13)	12.7 ± 1.3 (13)	12.4 ± 1.4 (12)
0-6	12.9 ± 1.0 (13)	13.2 ± 1.5 (13)	12.9 ± 1.3 (13)	12.9 ± 1.8 (12)

[a]Mean ± SD; [b]Median; [c]n ranges from 12-15, 11-12, 23-28 and 15-24 for high, upper intermediate, lower intermediate and low SES groups, respectively; [d,e]Means in rows with different superscripts differ significantly ($p<0.05$).

Table 5.35. Total, animal and plant protein intakes of pregnant and lactating women classified by household socioeconomic status (longitudinal data)

	Household socioeconomic status			
	High	Upper Intermediate	Lower Intermediate	Low
	n=15	n=12	n=30	n=22
		Total protein, g/d		
Pregnancy, trimester				
2	67.3 ± 16.9[a] (67)[b]	59.2 ± 14.4 (56)	64.3 ± 14.9 (61)	60.5 ± 14.8 (56)
3	56.4 ± 12.9 (58)	59.3 ± 16.8 (52)	61.9 ± 16.6 (59)	61.2 ± 16.2 (64)
2 & 3	61.6 ± 13.8 (61)	57.9 ± 10.9 (54)	64.1 ± 14.9 (61)	61.7 ± 13.1 (61)
Lactation, mo				
0-3	66.4 ± 11.6 (68)	64.8 ± 19.9 (67)	69.8 ± 18.2 (65)	67.9 ± 16.6 (63)
3-6	66.1 ± 11.4[c,d] (64)	69.8 ± 10.9[c] (70)	64.3 ± 13.7[c,d] (64)	63.4 ± 12.4[d] (63)
0-6	67.5 ± 7.6 (68)	68.7 ± 10.8 (68)	67.3 ± 10.5 (64)	65.8 ± 12.3 (61)
		Animal protein, g/d		
Pregnancy, trimester				
2	26.9 ± 12.0[c] (27)	21.6 ± 14.0[c,d] (16)	21.9 ± 12.8[c,d] (18)	17.1 ± 11.3[d] (15)
3	19.7 ± 6.4[c,d] (19)	21.3 ± 14.7[c] (19)	20.9 ± 11.8[c] (19)	14.8 ± 8.7[d] (14)
2 & 3	23.2 ± 8.2[c] (22)	21.1 ± 10.3[c,d] (18)	22.1 ± 10.7[c] (18)	16.3 ± 8.0[d] (14)
Lactation, mo				
0-3	23.9 ± 12.4 (22)	24.9 ± 17.1 (21)	26.3 ± 18.9 (21)	21.1 ± 19.2 (18)
3-6	21.1 ± 6.9[c,d] (21)	24.3 ± 12.5[c] (22)	20.0 ± 10.3[c,d] (18)	17.8 ± 8.8[d] (15)
0-6	22.7 ± 7.9 (22)	25.3 ± 11.9 (24)	22.4 ± 8.6 (21)	19.5 ± 11.2 (16)
		Plant protein, g/d		
Pregnancy, trimester				
2	40.5 ± 9.6 (45)	37.4 ± 5.9 (37)	42.3 ± 11.6 (43)	43.3 ± 7.9 (41)
3	36.9 ± 10.2 (36)	37.9 ± 6.0 (37.5)	40.9 ± 10.5 (38)	46.5 ± 12.5 (45)
2 & 3	38.4 ± 9.2[c,d] (38)	36.9 ± 4.2[c] (38)	41.9 ± 9.1[c,d] (40)	45.3 ± 8.3[d] (44)
Lactation, mo				
0-3	42.6 ± 9.0 (44)	39.8 ± 11.1 (38)	43.4 ± 10.7 (43)	46.9 ± 12.6 (48)
3-6	45.1 ± 9.0 (44)	45.7 ± 9.3 (43)	44.3 ± 8.4 (42)	45.6 ± 7.3 (46)
0-6	44.7 ± 6.0 (45)	43.6 ± 8.1 (41)	44.9 ± 7.4 (44)	46.4 ± 7.1 (47)

[a]Mean ± SD; [b]Median; [c,d]Means in rows with different superscripts are significantly different ($p<0.05$).

Table 5.37. Anthropometry of pregnant women (longitudinal data)

	Stage of gestation	
	3 months[a]	9 months[b]
9 months[b]		
	(n=63)	
Height, cm	155.3 ± 5.0[c] (155.5)[d] 143.7 - 167.4[e]	---
Body weight, kg	60.9 ± 10.2 (58.6) 44.8 - 92.4	68.8 ± 10.1 (69.0) 49.6 - 95.5
% Ideal weight for height[f]	114 ± 18.0 (111) 90 - 168	129 ± 17.0 (127) 99 - 174
Body mass index	25.2 ± 4.0 (24.4) 19.6 - 37.0	---
Body weight change[g], kg	---	7.9 ± 3.7 (7.5) -0.9 - 17.8
Arm circumference[h], cm	25.8 ± 3.6 (25.4) 21.0 - 37.0	25.9 ± 2.8 (25.5) 21.0 - 32.5
Biceps skinfold[i], mm	9.8 ± 5.5 (9) 4 - 25	10.5 ± 6.7 (10) 4 - 34
Triceps skinfold[i], mm	18.3 ± 7.7 (18) 7 - 36	19.4 ± 8.3 (20) 7 - 44

[a]Birth - 190 ± 30 days
[b]Birth - 15 ± 15 days
[c]Mean ± SD
[d]Median
[e]Range
[f]Jelliffe, D.B. The Assessment of the Nutrition Status of the Community. World Health Organization, Geneva, 1966;240-1.
[g](Birth - 15 ± 15 days) - (Birth - 190 ± 30 days)
[h]n=33
[i]n=31

Table 5.46. Frequency distribution of infants by percentiles of weight at different ages (longitudinal data)

Sex and age	Percentiles of weight (NCHS)[a]							
	<5	5-10	10-25	25-50	50-75	75-90	90-95	>95
				% of infants				
Male								
Birth (40)[b]	2.5 (1)	- -	20.0 (8)	20.0 (8)	37.5 (15)	15.0 (6)	5.0 (2)	- -
1 month	2.5 (1)	2.5 (1)	10.0 (4)	32.5 (13)	27.5 (11)	17.5 (7)	5.0 (2)	2.5 (1)
3 months	5.0 (2)	5.0 (2)	10.0 (4)	32.5 (13)	35.0 (14)	12.5 (5)	- -	- -
6 months	15.0 (6)	17.5 (7)	25.0 (10)	22.5 (9)	15.0 (6)	5.0 (2)	- -	- -
				% of infants				
Female								
Birth (33)	3.0 (1)	3.0 (1)	21.2 (7)	27.3 (9)	21.2 (7)	9.1 (3)	12.1 (4)	3.0 (1)
1 month	- -	- -	15.2 (5)	30.3 (10)	30.3 (10)	15.2 (5)	9.1 (3)	- -
3 months	3.0 (1)	3.0 (1)	15.2 (5)	36.4 (12)	21.2 (7)	9.1 (3)	9.1 (3)	3.0 (1)
6 months	12.1 (4)	18.2 (6)	24.2 (8)	37.3 (9)	12.1 (4)	6.0 (2)	- -	- -

[a]National Center for Health Statistics
[b]Number of infants

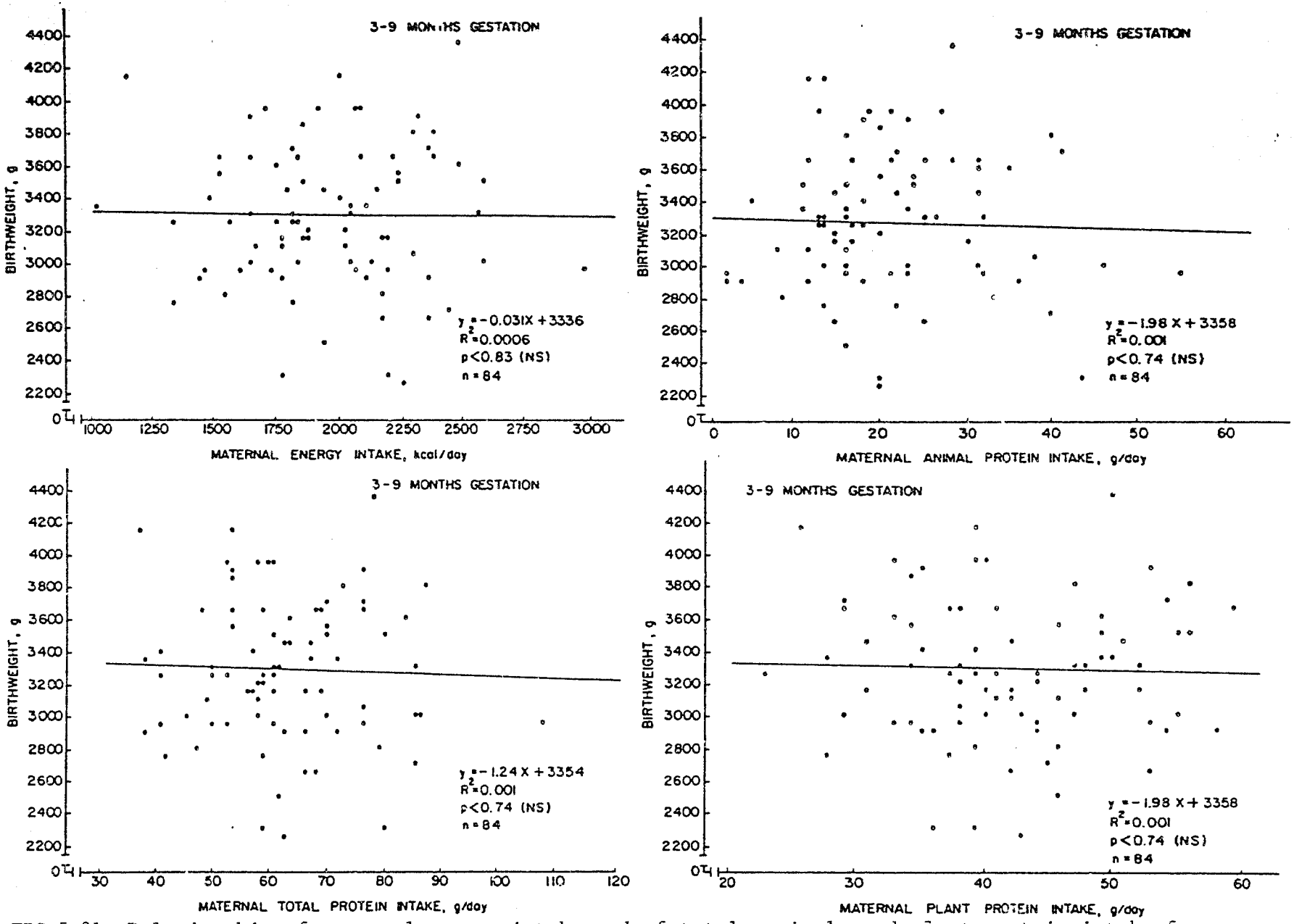
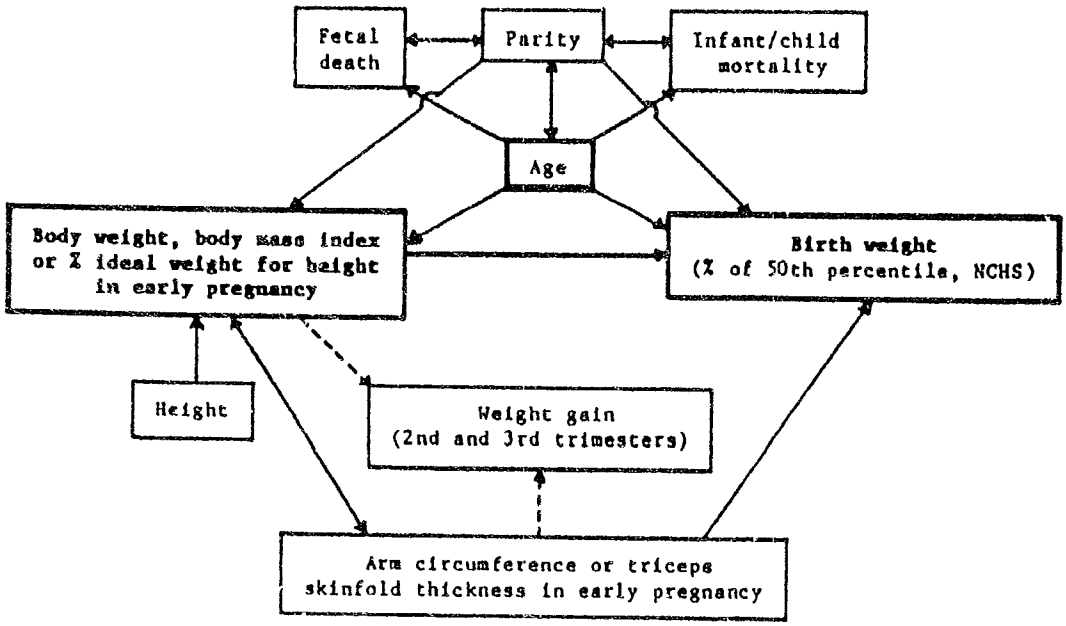


FIG 5.21. Relationship of maternal energy intake and of total, animal, and plant protein intake from 3 to 9 months gestation to birthweight

Table 5.53. Multiple regression analysis for predicting early pregnancy weight and weight gain during the second and third trimesters

Independent variable	Regression coefficient	SE	p	R^2
Dependent variable: Early pregnancy weight, kg (n=72)				
Age, years	0.66	0.17	0.0003	0.25
Height, cm	0.59	0.21	0.004	
Intercept	-48.3	32.8		
Dependent variable: Weight gain, kg (n=63)				
Age, years	-0.32	0.11	0.004	0.17
Parity	0.88	0.25	0.05	
Intercept	12.6	2.2		

(A) SIMPLE REGRESSIONS



(B) MULTIPLE REGRESSION

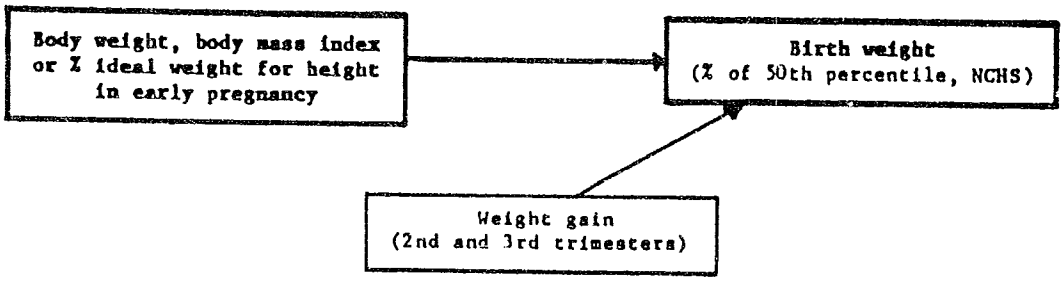


FIG 5.23. Summary of variables related to birth weight by simple regression (A) and multiple regression (B) analyses. ——— significant effect ($p<0.05$); - - - trend ($p<0.10$)

2. Maternal Food Intake

Maternal mean energy intake (total Kcal/day) during the first 6 months of lactation (Figure 5.27) was significantly related to infant weight at 6 months of age, expressed as percent of the 50th percentile (R^2=0.12, $p<0.003$). Maternal energy intake from only fat and carbohydrate sources (Kcal/day) also had a significant effect (R^2=0.13, $p<0.001$) on infant weight at 6 months (Figure 5.27). Maternal plant protein intake, which had a significant effect on infant weight at 6 months (R^2=0.09, $p<0.009$), appeared to be a proxy for energy intake. Animal protein intakes from 0 to 6 months, were not related significantly to infant weight (Figure 5.27). Maternal total protein intake also had a significant effect on infant weight at 6 mo (R^2=0.14, $p<0.001$). Multiple regression models for predicting infant weight at 6 months of age (Section 0) showed that the best two-variable model included either the diarrhea or SES variable and maternal plant protein intake (g/day) during the first 6 months of lactation. In other models, the use of either maternal plant protein intake or energy intake for predicting weight at 6 months did not change the predictive power. Clearly maternal energy and/or plant protein intake during lactation were associated with infant weight at 6 months of age.

Table 5.63. Relationship of certain household and maternal variables to household sanitation by simple regression analyses

Independent variable	n	Regression coefficient	SE	p	R^2
Household					
Socioeconomic status[a]	107	-1.17	0.03	0.0001	0.18
Intercept		3.90	0.11		
Mother					
Education, yrs	107	0.04	0.02	0.04	0.04
Intercept		3.39	0.04		
Food intake, 0-6 mo postpartum					
Kcal/d	88	0.00002	0.00016	0.91(NS)	0.0002
Intercept		3.40	0.34		
Total protein, g/d	88	0.005	0.004	0.21(NS)	0.02
Intercept		3.10	0.27		
Animal protein, g/d	88	0.01	0.004	0.001	0.11
Intercept		3.12	0.10		
Plant protein, g/d	88	-0.012	0.006	0.03	0.06
Intercept		4.01	0.25		
Hematology, 0-3 mo postpartum					
Hemoglobin, g/dl	62	0.06	0.03	0.07	0.06
Intercept		2.75	0.37		
Ferritin, ug/dl	57	0.005	0.002	0.05	0.07
Intercept		3.28	0.08		

[a]1=high and 4=low SES groups

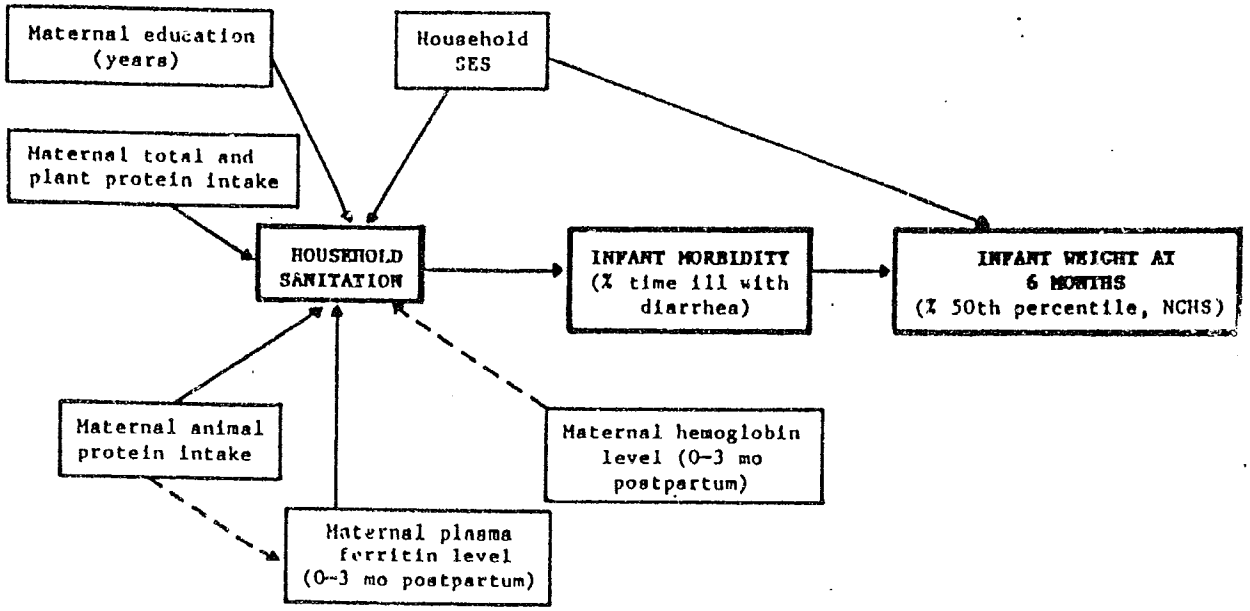


FIG 5.26. Summary of variables related to household sanitation and the relationship of these to infant morbidity and weight at 6 months by simple regression analyses. ——— significant effect ($p<0.05$); - - - trend ($p<0.10$)

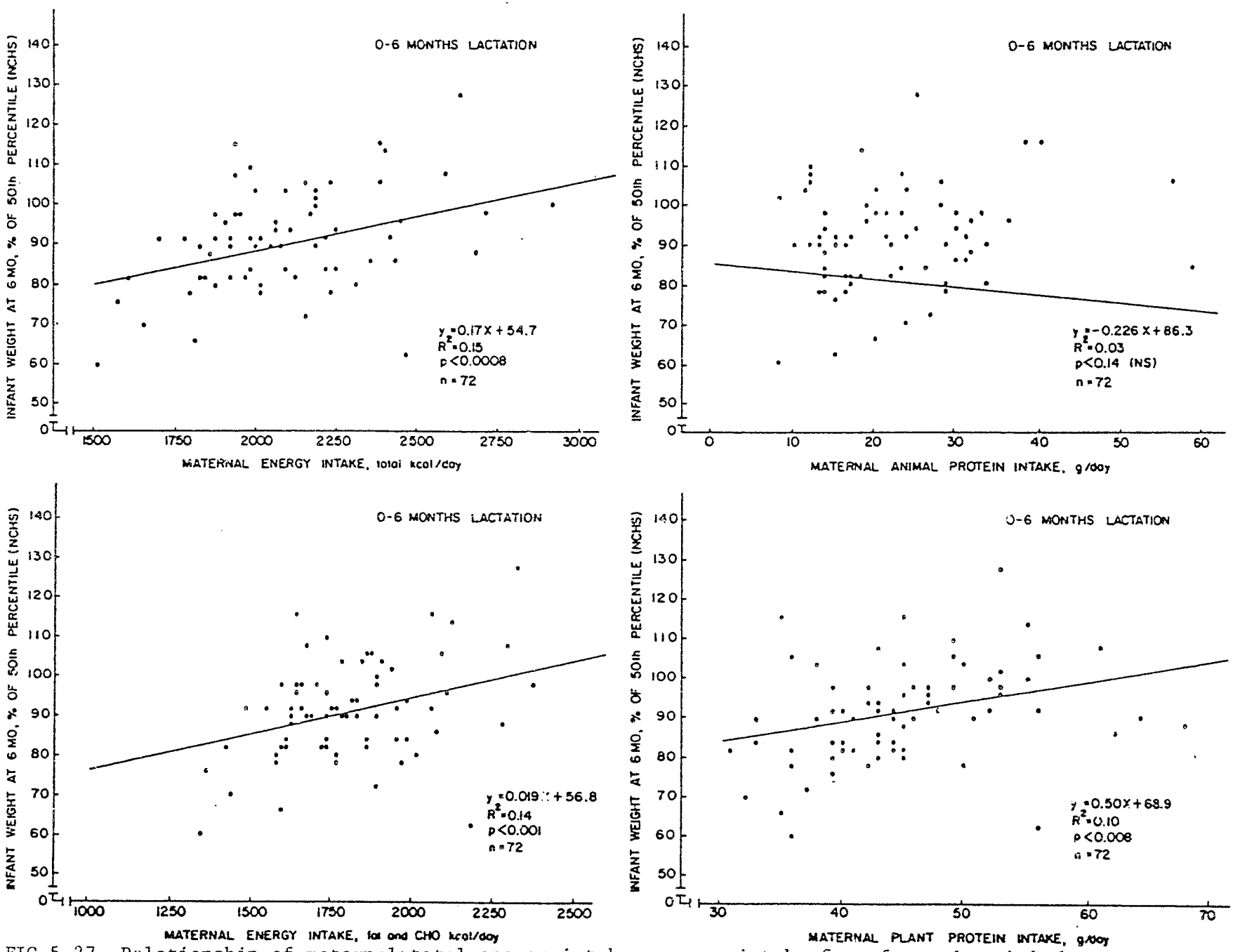


FIG 5.27. Relationship of maternal total energy intake, energy intake from fat and carbohydrate, and animal and plant protein intake during the first 6 months of lactation to infant weight at 6 months of age

Table 5.65. Comparison of growth, morbidity, and selected variables for infants classified into three categories of weight at 6 months

	Classification of infant weight at 6 months % of 50th percentile (NCHS)[a]		
	<90	90-100	>100
Infant weight	(n=34)	(n=26)	(n=14)
		% of 50th percentile	
Birth	95.2 ± 11.1[b,c] 69 -120[g]	103.2 ± 10.9[d] 86 - 123	103.1 ± 10.0[d] 85 - 117
1 month	94.6 ± 10.4[c] 71 - 115	107.3 ± 10.8[d] 90 - 138	106.8 ± 9.9[d] 89 - 124
3 months	90.6 ± 10.0[c] 69 - 108	103.3 ± 8.5[d] 84 - 126	109.6 ± 8.5[e] 96 - 124
6 months	80.9 ± 6.6[c] 60 - 89	94.4 ± 3.5[d] 90 - 99.9	107.2 ± 4.8[e] 100 - 116
		Change in % of 50th percentile	
0 to 6 months	-14.2 ± 12.0[c] -37.7 - 14.8	- 8.7 ± 10.3[c] -27.1 - 13.4	4.1 ± 10.4[d] -16.6 - 24.0
	(n=28)	(n=23)	(n=11)
		% time sick	
Diarrheal illness 0 to 6 months	5.09± 6.2 0 - 21.0	3.76± 4.73 0 - 14.9	1.95± 3.44 0 - 10.7
Respiratory illness 0 to 6 months	6.09± 6.9 0 - 24	4.16± 5.94 0 - 19	4.67± 6.65 0 - 22
Supplementation	(n=28)	(n=20)	(n=11)
		Number of foods	
0 to 3 months	0.82± 1.19 0 - 4	0.55± 0.89 0 - 3	0.36 ± 0.92 0 - 3
3 to 6 months	2.86± 3.60 0 - 14	3.40± 5.11 0 - 22	1.73± 1.79 0 - 5
0 to 6 months	3.68± 4.29 0 - 17	3.95± 5.11 0 - 22	2.09± 2.30 0 - 6
Household			
Sanitation index	3.40± 0.43 2.69- 4.30	3.44± 0.40 2.74- 4.48	3.42± 0.41 2.66- 4.18
Socioeconomic status[f]	3.12± 0.91[c] 1 - 4	2.65± 1.09[c,d] 1 - 4	2.21± 0.70[d] 1 - 4
Maternal food intake, 0-6 months	(n=26)	(n=24)	(n=13)
Animal protein, g/day	22.5 ± 10.5 8 - 59	21.9 ± 7.5 12 - 36	23.2 ± 14.1 8 - 56
Plant protein, g/day	43.1 ± 8.3 31 - 68	45.9 ± 6.1 33 - 56	47.3 ± 8.0 35 - 61
Kcal/day	2147 ± 281 1522 - 2683	2081 ± 292 1700 - 2927	2192 ± 206 1931 - 2588

[a]National Center for Health Statistics; [b]Mean ± SD; [c-e]Means in rows with different superscripts differ significantly ($p<0.05$); [f]1=high and 4=low SES groups; [g]Range

Table 5.71. Simple regressions of independent variables with infant weight at 6 months expressed as percent of the 50th percentile (NCHS)

Independent variable	n	Regression coefficient	SE	p	R^2
Mother					
Height, cm	77	0.56	0.28	0.05	0.05
Intercept		4.20	43.5		
Weight, 6 mo postpartum, kg	52	0.27	0.15	0.07	0.07
Intercept		74.9	9.6		
Arm circumference, 6 mo postpartum, cm	55	1.04	0.45	0.03	0.09
Intercept		64.6	12.3		
Biceps skinfold thickness, 6 mo postpartum, mm	55	0.48	0.24	0.05	0.07
Intercept		86.3	3.5		
Total protein intake, 0-6 mo postpartum, g/day	72	0.41	0.12	0.001	0.14
Intercept		63.7	8.5		
Plant protein intake, 0-6 mo postpartum, g/day	72	0.50	0.18	0.008	0.10
Intercept		69.0	8.4		
Energy intake, 0-6 mo postpartum					
Total, Kcal/d	72	0.02	0.005	0.0008	0.15
Intercept		54.7	10.6		
Fat and CHO, Kcal/d	72	0.02	0.006	0.001	0.14
Intercept		56.8	10.5		
Infant					
Birth weight, % of 50th percentile (NCHS)[a]	74	0.36	0.11	0.002	0.13
Intercept		55.0	11.0		
% time ill with diarrhea	62	-0.77	0.25	0.004	0.13
Intercept		94.0	1.68		
Household					
Socioeconomic status[b]	83	-2.89	1.29	0.03	0.06
Intercept		98.7	3.81		

[a]National Center for Health Statistics
[b]1=high and 4=low SES groups

Table 5.72. Multiple regression models for predicting household sanitation from certain household and maternal variables

Independent variable	n	Regression coefficient	SE	p	R^2
Model 1					
Socioeconomic status[a]	88	-0.17	0.04	0.0001	0.29
Maternal animal protein intake, g/day, 0-6 mo postpartum		0.011	0.004	0.004	
Intercept		3.65	0.15		
Model 2					
Socioeconomic status	57	-0.17	0.05	0.0002	0.26
Maternal plasma ferritin status, ug/dl, 0-3 mo postpartum		-0.004	0.002	0.09	
Intercept		3.78	0.16		

[a]1=high and 4=low SES groups

1. Infant Weight At 3 Months

In constructing the multiple regression model for the prediction of infant weight at 3 months, initially 32 cases and all 15 variables were used, resulting in an R^2 of 0.59. Due to the relatively small number of cases and large number of variables, overfitting was likely. The CP criterion indicated that percent of the 50th percentile weight (NCHS) at birth was the best single predictor (R^2=0.35) of infant weight at 3 months and that maternal plant protein intake during the first 3 months postpartum was the next best single predictor (R^2=0.21). The CP criterion pointed to the best prediction model as one which contained two variables: percent of the 50th percentile weight at birth and maternal plant protein intake (R^2=0.43). When these two variables were used in the model, the number of cases was increased to 52 and R^2 increased to 0.47 (Table 5.73). When maternal total Kcal intake or Kcal intake from fat and carbohydrate was substituted in the model for plant protein intake, the R^2 dropped to 0.30-0.31 after each substitution in the model. Simple regressions also demonstrated a higher predictive power of maternal plant protein intake than Kcal intake for infant weight at 3 months.

2. Infant Weight At 6 Months

Initially in this analyses, 34 cases and all of the 15 variables described previously were used in the model resulting in an R^2 of 0.69. Again, overfitting was likely. The CP criterion suggested examination of a number of two-, three- and four-variable models with R^2 ranging from 0.43 to 0.56. Maternal plant protein intake was the best single predictor (R^2=0.30) of infant weight at 6 months, and the next best predictor was household SES (R^2=0.23). The best two-variable combination included maternal plant protein intake and percent of time the infant was ill with diarrhea (R^2=0.43) and were included in virtually all reasonable models that included more than two variables. The second best two-variable predictor model for infant weight at 6 months included socioeconomic status instead of diarrhea (R^2=0.39).

Table 5.73. Multiple regression models for predicting infant weight expressed as percent of the 50th percentile (NCHS)[a] at 3 and 6 months of age

Independent variable	Regression coefficient	SE	p	R^2
		n=52		
		Weight at 3 months		
Model 1				
Birth weight, % of 50th percentile	0.58	0.13	0.0001	0.47
Maternal plant protein intake, g/d[b]	0.59	0.13	0.0001	
Intercept	15.9	13.8		
Model 2				
Birth weight, % of 50th percentile	0.56	0.14	0.0003	0.31
Maternal energy intake from fat and CHO, Kcal/d[b]	0.0102	0.0040	0.02	
Intercept	25.0	16.0		
Model 3				
Birth weight, % of 50th percentile	0.55	0.14	0.0004	0.30
Maternal energy intake, total Kcal/d[b]	0.0089	0.0037	0.02	
Intercept	25.5	16.0		
		Weight at 6 months		
Model 1				
Birth weight, % of 50th percentile	0.42	0.12	0.001	0.43
% time sick with diarrhea	-0.60	0.25	0.02	
Socioeconomic status[c]	-3.00	1.33	0.03	
Maternal plant protein intake, g/d[b]	0.48	0.17	0.007	
Intercept	38.5	14.4		
Model 2				
Birth weight, % of 50th percentile	0.44	0.13	0.004	0.39
% time sick with diarrhea	-0.63	0.25	0.02	
Socioeconomic status[c]	-3.17	1.38	0.03	
Maternal energy intake from fat and CHO, Kcal/d[b]	0.010	0.005	0.05	
Intercept	44.0	15.0		
Model 3				
Birth weight, % of 50th percentile	0.39	0.13	0.006	0.39
% time sick with diarrhea	-0.61	0.25	0.02	
Socioeconomic status	-3.15	1.37	0.03	
Maternal energy intake, total Kcal/d[b]	0.01	0.005	0.04	
Intercept	43.1	15.0		

[a]National Center for Health Statistics
[b]Mean, 0-6 months postpartum
[c]1=high and 4=low SES groups

When the candidate models were tested using multiple regression analysis, the sample size was increased to 52 and the R^2 value decreased. In the first model that included percent of time the infant was sick with diarrhea and maternal plant protein intake, the R^2 value dropped to 0.27. The addition of socioeconomic status and birth weight, expressed as percent of the 50th percentile, to the model which included percent of time the infant was ill with diarrhea and maternal plant protein intake, increased the R^2 from 0.27 to 0.43 (Table 5.73). When either maternal total Kcal intake or Kcal intake from non-protein sources was substituted for maternal plant protein intake in the model, an R^2 of 0.39 resulted. Thus the use of either maternal plant protein intake or energy intake for predicting infant weight at 6 months did not change the predictive power of the model. Animal protein intake, however, was not related to infant weight at 6 months in this model. Although simple regression analysis showed significant relationships between maternal anthropometric measures at 6 months postpartum and infant weight, these measures were not significant in multiple regression analysis. This is due, in part, to the significant relationship between maternal anthropometry and birth weight and the presence of birth weight in the model. These results clearly indicated that morbidity of the infant (or the percent of time the infant was ill with diarrhea), birth weight, household socioeconomic status, and maternal food intake, either energy or plant protein, were associated in the expected directions with the weight of the infant at 6 months.

P. Other Multiple Regression Models Related to Infant Weight

To study the effect of different variables on infant weight change over the first 6 months, the same sets of independent variables listed in the previous section were regressed with change in weight percentiles from birth to six months of age. In this analysis, the same variables which were significant predictors of weight at 6 months (Table 5.73) were also significant predictors of change in weight percentiles (Table 5.74). The latter analysis explained a higher percentage of variation in the dependent variable (R^2=0.52 to 0.55) than the former analysis. The negative relationship observed between birth weight (% of the 50th percentile) and weight change, shown by multiple regression analysis, was shown previously by simple regression.

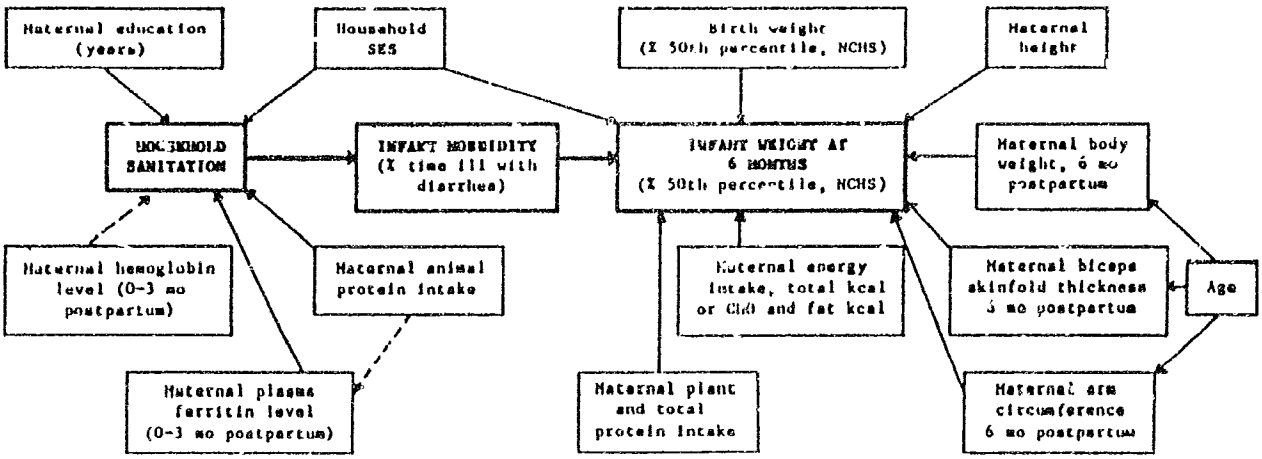
A summary of all simple and multiple regression analyses of various independent variables (discussed in this section) with household sanitation, infant morbidity, and infant weight at 6 months is presented in Figure 5.31.

Table 5.... Multiple regression models for predicting change in infant weight expressed as percent of the 50th percentile (NCHS)[a] from birth to 6 months of age

Independent variable	Regression coefficient	SE	p	R^2
	Change in weight percentile, birth to 6 months (n=52)			
Model 1				
Birth weight, % of 50th percentile	-0.58	0.12	0.0001	0.55
% time sick with diarrhea	-0.60	0.25	0.02	
Socioeconomic status[b]a	-3.00	1.33	0.03	
Maternal plant protein intake, g/d[c]	0.48	0.17	0.007	
Intercept	38.5	13.9		
Model 2				
Birth weight, % of 50th percentile	-0.60	0.13	0.0001	0.52
% time sick with diarrhea	-0.63	0.25	0.02	
Socioeconomic status[b]	-3.17	1.38	0.03	
Maternal energy intake from fat and CHO, Kcal/d[c]	0.010	0.005	0.05	
Intercept	44.0	15.0		
Model 3				
Birth weight, % of 50th percentile	-0.61	0.13	0.0001	0.52
% time sick with diarrhea	-0.61	0.25	0.02	
Socioeconomic status[b]	-3.15	1.37	0.03	
Maternal energy intake, Kcal/d[c]	0.010	0.005	0.04	
Intercept	43.1	15.0		

[a]National Center for Health Statistics
[b]1=high and 4=low SES groups
[c]0-6 months postpartum

(A) SIMPLE REGRESSIONS



(B) MULTIPLE REGRESSION

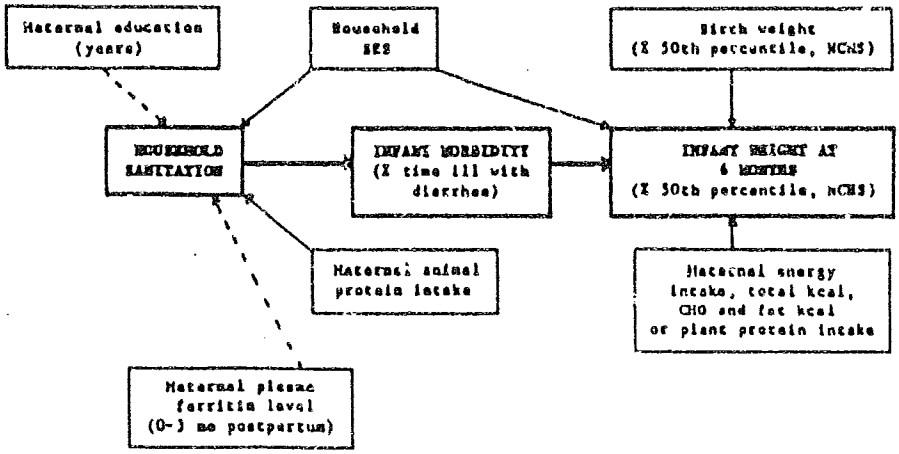


FIG 5.31. Summary of variables related to infant weight at 6 months of age by simple regression (A) and by multiple regression (B) analyses.
——— significant effect ($p<0.05$); - - - trend ($p<0.10$)

THE COLLABORATIVE RESEARCH SUPPORT PROGRAM
ON
FOOD INTAKE AND HUMAN FUNCTION

EGYPT REPORT

FINAL REPORT

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DEDICATION

This report is dedicated to the men, women and children of Kalama, Egypt. The research reported in this volume would not have been possible without their enthusiastic response to the project and its investigators. Our hope is that appropriate policy and programs will emanate soon from the findings of this research and that Kalama residents will be the initial beneficiaries.

TRIBUTE TO DR. FORMAN

We are very sorry to learn of the untimely death of Dr. Martin J. Forman, Director of the Office of Nutrition, Agency for International Development. In his honor and memory, we plan to increase our efforts to continue the activities begun under the Nutrition CRSP which he believed in and supported.

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Chapter 1

INTRODUCTION

I. BACKGROUND

The situation of mild or moderate deficits of food intake is prevalent in most of the world's population, and yet to date, its functional effects have not been studied systematically. The problem of millions of chronically undernourished and malnourished persons in the world, many of them young children and pregnant women, does not elicit the same response from governments and people as the horrors of famine and starvation. Nevertheless, millions of people are believed to die each year from inadequate food intake combined with poor sanitary conditions and chronic disease. Among those who survive, many are believed to never reach their full physical and mental potential. There is recognition that these assumptions have yet to be appropriately documented and that until this is done, there will be great uncertainty about the national and international policies and actions intended to ameliorate the perceived situation.

Conceptualization of the Nutrition Collaborative Research Support Program (CRSP) evolved from a series of reports and working papers extending back to 1975. A report of a National Academy of Sciences panel assigned the highest priority area for research bearing on world food and nutrition issues to determining the functional significance of nutritional status (National Academy of Sciences, 1977). At the request of the U.S. Agency for International Development (USAID), the Committee on International Nutrition Programs of the Food and Nutrition Board, National Research Council convened a workshop in 1977 to consider research that might lead to a functional definition of nutritional status. As a result, five broad areas of human function were identified for investigation of their relationship to marginal food intake: disease response, reproductive capacity, work output/physical activity, cognitive development and social competence (Food and Nutrition Board 1978).

Under a USAID planning grant awarded to the University of California, Berkeley, a series of workshops were convened to further define the issues and the research approaches in each of the five major areas of function. The precis of the workshops included several important directives for the research: 1) the unit of study should be the household and the focal point the mother-child dyad; 2) food intake, the major independent variable, should be represented by a range of energy intakes from habitually mild to moderately restricted; 3) the design of the research should be naturalistic rather than intervention; and 4) findings should be generalizable to nutrition problems in technologically developing countries and should have potential policy and program implications.

Against this background, the Nutrition CRSP, a 5-year program (1982-87) funded by USAID, was designed to investigate the human functional effects of mild to moderate undernutrition in three countries: Egypt, Kenya and Mexico. The central question to be addressed by the Nutrition CRSP research was: "Under the conditions of mild to moderate undernutrition, what relationships exist cross-culturally between food intake and various human functional outcomes?" Priority was given to a research strategy in which broad sets of cross-disciplinary variables were investigated in relation to food intake.

II. EGYPT PROJECT OBJECTIVES AND HYPOTHESES

Data from the National Nutrition Survey of Egypt (1978-80) demonstrated that chronic undernutrition, i.e. mild and moderate deficits of food intake, was common in Egypt, but acute undernutrition was rather rare. Yet to date, the functional consequences of this situation have not been systematically investigated. Thus the major objectives of the Egypt Project, Nutrition CRSP were:

A) to investigate prospectively in a rural Egyptian setting the effects of mild to moderate variation in energy intake on human functional performance in terms of: morbidity frequency, duration and severity; pregnancy outcome; cognitive development; and child care and sanitation;
B) to develop and validate techniques and instruments for field research in human nutrition; and
C) to assist Egypt in institution-building and in the development of infrastructure to improve nutrition services.

The principal research hypotheses which the Egypt Project, Nutrition CRSP was designed to test were:

A) Maternal food intake during pregnancy and lactation influences endowment at birth and during the infant's first six months of breastfeeding. Also, maternal intake affects maternal activities for sanitation and child care. Thus, infant behavior and morbidity are affected by maternal food intake;
B) Food intake of the child between 18 and 30 months affects his/her morbidity, anthropometry, and psychological development while maternal intake affects her child care and sanitary practice. Thus, behavior and morbidity of the young child are affected by both the child's and the mother's food intake;
C) Food intake of the child between 7 and 9 years affects the child's morbidity and behavior while intake of the parents affects their behavior toward the child;
D) Food intake of adults affects their morbidity, responsiveness and performance of usual responsibilities and that this, in turn, affects the morbidity and performance of other household members;
E) Household food intake affects household morbidity.

III. AFFILIATED INSTITUTIONS AND COLLABORATIVE ROLES

The Management Entity of the Nutrition CRSP at the University of California, Berkeley was responsible for the scientific coordination and fiscal administration of the overall project. Five U.S. institutions were involved in the collaborative research effort along with three host country institutions; these included the Universities of Arizona, Kansas and Purdue and the Nutrition Institute in Egypt; the University of Connecticut and the National Institute of Nutrition in Mexico; and the University of California (Los Angeles) with the University of Nairobi in Kenya. Scientific decisions of the Nutrition CRSP were handled by a Scientific Coordinating Board which met twice yearly and which was composed of one U.S. and one host country principal investigator from each of the three projects and one representative from Management Entity.

A full-time field coordinator, who in most cases was a staff member of the U.S. component of each project, was employed to reside in the host country. Generally, this person functioned both as field coordinator and liaison for day-to-day scientific operations as well as for administration and financial liaison between the U.S. institutions and host country institutions. Host country field staff were the primary field workers in the project, and scientists of the host country were involved fully in the collaborative work. U.S. investigators communicated regularly and frequently with their host country counterparts, provided consultation and needed training of field staff and others when appropriate, and were in the host countries sufficiently often and for long enough periods of time to function in a fully collaborative role.

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Chapter 2

THE SITE

I. SELECTION

A. Selection of Kalama, a Village in the Nile Delta

Kalama, a village of 1470 households in 1982 (8,544 individuals) covering 1,762 feddans[1] in the Nile Delta was selected from among six potentially eligible communities as the research site.

B. Criteria for Community Selection

To be eligible for consideration, a site was expected to meet the following conditions:

1) a well-defined rural community such as a village, that is physically accessible to non-residents;
2) a stable population of at least 700 households with little emigration to other countries or out-migration to neighboring towns and cities;
3) a representative population reflecting the religion(s), economic structure, food and feeding patterns and traditions of rural populations in lower Egypt;
4) a representative population with a range of nutritional states from adequate to mild-to-moderately undernourished;
5) absence of endemic nutritional diseases such as goiter;
6) absence of chronic disease conditions such as bilharzia in a significant proportion of the population;
7) a health center with a resident physician and adequate supportive staff;
8) at least one primary and one preparatory school;
9) located within daily commuting distance from the Egypt Nutrition Institute or not more than 40 Km. from Cairo;
10) no current or proposed intensive research projects involving nutrition, agricultural development, or fertility control.

Six communities were observed, reviewed and evaluated to determine provisional eligibility. Some relevant features of these communities are presented in Table 2.1.

C. The Site Selection Process

Site selection involved five processes:

1) establishing site eligibility criteria;
2) observing, reviewing, and evaluating communities to determine provisional eligibility;

[1] One feddan equals 1.038 acres.

3) identifying one provisionally eligible community for conducting Phase I research;
4) securing official and community approval of the research plan and project;

5) implementing pre-Phase I research to determine the number of households eligible for Phase II research. Each process is described below.

A team of five investigators from Egypt and the United States who had participated in at least two site reviews, unanimously selected Kalama as the provisional research site. Kalama met all of the criteria established for site selection. In addition, the resident physician of Kalama seemed enthusiastic about participating in a prospective research project; he felt that the community residents would be cooperative. Staff at the N.I. who had conducted a survey in Kalama from 1965-1967 were also impressed with the quality and level of community support and cooperation received during that time.

D. Securing Official and Community Approval of the Research Plan and Project

Official approval for implementing the research plan in Kalama was granted by both the Undersecretary of Health and the Undersecretary of Agriculture. They provided official clearance to obtain relevant data from health and agricultural officers in Kalama. The Village Council in Kalama also approved the project. In addition, two social workers from the Nutrition Institute informally surveyed key informants in Kalama about the proposed plan and project and received very positive reaction from those surveyed.

II. PHYSICAL SETTING

A. Location

One enters Kalama from one of the busiest highways in Egypt. It is situated 25 kilometers north of downtown Cairo, just 500 meters from Al Tarik Al Zerai, the main north-south artery linking Cairo and Alexandria. However, immediately upon entering the village, one is comforted by the relatively slow, steady pace of village life compared with the hustle and bustle of the highway. Kalama is one of many villages in the Kaliobia governorate. The residential section covers a total area of 1,762 feddans (approximately 1,830 acres). Surrounding farms cover a total area of 2,867 feddans. The residential area is divided into three main sections: the gurn (granary), the madafin (cemetery) and the agricultural cooperative section.

The road leading from the highway to the center of the village is one of Kalama's main arteries. It is bordered by farms for about one-half kilometer

Encroaching upon the fertile farmland are neighboring large two-storied brick houses, followed by traditional one-storied brick, adobe-brick, or adobe buildings.

Two important public buildings are located close to the main entry, obliquely opposite each other on the main street - the food cooperative and the health services center, Almagmoa Al Sihiya. The health center is 700 meters from the agricultural section and 500 meters from the gurn and madafin. As the main street curves through the village, it is dotted with a variety of commercial enterprises including fast food stands, vegetable and fruit stands, confectionery, soft drink and snack stands, television and bicycle repair shops, carpentry shops, etc. El-Omda Mosque is located in the heart of "main street" and borders one section of the S-shaped canal which meanders through the village. Many important elements of village social life are played out along the banks of the village canal. The local market (el soq) and other commercial enterprises are located in other sections of the village. A map of Kalama is presented in Figure 2.1.

Farmers of both sexes assisted by children of all ages move through "main street" on their animals - either going to their farms laden with animal manure or coming from their farms laden with animal fodder. At the same time, commuters and vendors hail trucks and vans for Cairo.

TABLE 2.1.
Characteristics of villages reviewed during site selection

Criteria	Village name and characteristics*					
	Zeidia	Kafr Hakim	Kafr El-Khadrea	Shalakan	Kalama	Nediba
Name of governorate	Giza	Giza	Monofia	Kaliobia	Kaliobia	El-Beheria
Distance from Nutrition Institute (km)	25	25	55	25	25†	200
Type of health care delivery system	rural health unit	rural health unit	health center	rural health unit	health center	health center
Presence of doctor at center	yes	no	yes	no	yes	yes
No. of personnel at center	10	11	32	16	28	30
Availability of food aid	yes	yes	yes	unsure	no	yes
Stability of population	yes	yes	yes	no	yes	yes
Approx. no. of households	900	1,500	1,800	unsure	1,550	600
Presence of housing enumeration system	yes	yes	no	unsure	yes (with file for each hh)	yes

* Primary and preparatory schools in all villages as well as community social centers and village council.

† Kalama is on the high-way road between Cairo and Alexandria, a 10 minute drive from the town, Shubra.

B. Geography and Climate

The terrain is extremely flat. There are no hills or mountains.

The climate is hot and humid, and rainfall is extremely sparse. Rain falls no more than six times per year, always in winter and usually very brief showers. The average temperature is 22^0C; the temperature ranges from 9^0C. to 34^0 C. Relative humidity varies from 58 to 65 percent with an average of 62 percent.

There are three distinct seasons - the very hot, humid, and dusty summer from April to August, the mild autumn from late September to November and the cool winters from December to March. Locally, each season is associated with its major agricultural products such as the citrus fruits of winter, the autumn dates, and tropical fruits such as water-melon, guava, and mangoes during the long summer months.

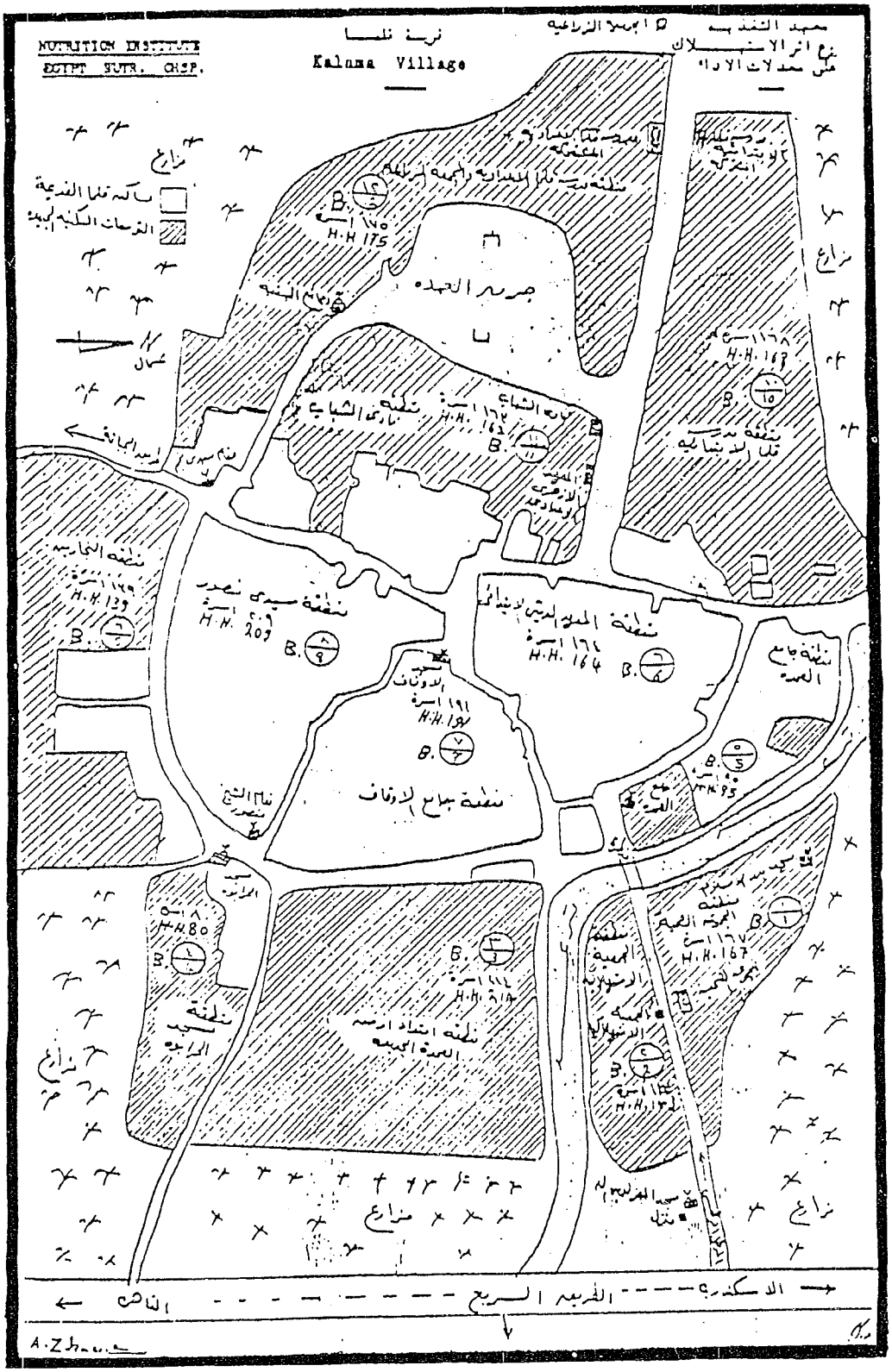

FIG 2.1. Map of Kalama.

III. SOCIAL AND ECONOMIC SETTING

The main road leading to and from the highway is paved; this differs from the unpaved, muddy (from water used for domestic purposes), and bumpy lanes inside the village. Kalama is fully electrified indoors and outdoors for street lighting. Approximately 10% of the homes have an indoor water supply and another 10% have water pumps very close to their houses. However, most Kalamans use communal water pumps located throughout the village.

The non-residential areas in Kalama consist of fertile arable land in which a wide variety of vegetables and some fruits are cultivated. The residential section is heavily dotted with a varied assortment of service-oriented commercial establishments.

Traditional Kalama houses are built of either mud or red brick. Typically, houses are one or two stories high and consist of two or three rooms. One room is used as a living area and all domestic activities are carried out in this room: feeding children, eating, preparing food, and serving tea and coffee to guests. A round, wooden, very short-legged dining table (tablaava) sits in the middle of this room. The floor is often covered with a cotton rug. Modern houses often have high, narrow sofas and metal beds. Family photographs usually cover the walls of the houses. The roofs of most houses are covered with dried plant stalks and animal dung; both are used as fuel. The barn of a traditional house is commonly located in the living quarters; however, in more modern houses, animals are located in separate quarters beside the main residence. Many families own modern appliances and electronic equipment such as a T.V. set, washing machine, refrigerator, radio, and a fan.

IV. VILLAGE LIFE AND SOCIOPOLITICAL INSTITUTIONS

A. Demographic Characteristics

In 1982, Kalama's 8,544 residents (1,470 households) represented one percent of the population of Kaliobia (1,913,000 people). The age distribution of the village population is presented in Table 2.2. Most Kalamans are young; 56.2% of the population were under 21 years of age in 1982. The mean age was 18.8 years. Household size varied widely, with a mean of approximately six individuals per household. However, for the majority of households, the range was four to seven individuals. Less then 1 percent of Kalama households consists of 15 individuals. Household size is depicted in Table 2.3.

The nuclear family, consisting of a married couple and their unmarried offspring, is the dominant family type in Kalama; two-thirds of all village households are of this family type. The remaining one-third are extended family households of two types. The first type is a multi-generation family consisting of a senior couple, their unmarried children (if any), a married son (usually the oldest), and the couple's unmarried children. The second type is similar to the first, with the addition of other married sons, their spouses, and their unmarried children. The latter family type is sometimes referred to as a joint family (Table 2.4). To add an important footnote to family structure, polygamy is practiced, but uncommon. There is also a strong feeling of kinship endogamy in the village; however, marriage to close kin is not exclusive.

TABLE 2.2.
Population distribution by age in years

Age range	Population (n = 8,259)	
	n	Percent
< 1	Not available	
1 - 3.99	1080	13.1
4 - 5.99	565	6.8
6 - 9.99	943	11.4
10 - 12.99	541	6.6
13 - 17.99	965	11.7
18 - 20.99	544	6.6
21 - 24.99	383	4.6
25 - 34.99	1191	14.4
35 - 44.99	809	9.8
45 - 54.99	536	6.5
55 - 64.99	431	5.2
65 - 74.99	201	2.4
75+	70	0.9

TABLE 2.3.
Population distribution by household size

Household size	Households (n=1,470)	
	n	Percent
1 - 3	273	18.6
4 - 7	859	58.4
8 - 11	293	19.9
12 - 20	45	3.1

TABLE 2..4
Distribution of households by family type

Family type	Households (n = 1,468)	
	n	Percent
Nuclear	1,005	68.5
Extended - Simple*	384	26.1
Extended - Joint†	79	5.4

* A family consisting of a senior couple, with married children (if any), a married son (usually the oldest), and the young couple's unmarried children.

† A family consisting of a senior couple, with unmarried children (if any), married sons, their spouses, and unmarried children.

Kalama is a Moslem community with 1,459 Moslem households (99.3%) and only 11 Christian households (0.7%). The predominance of Islam is reflected in the presence of 6 mosques in different parts of the village. Four of these mosques were constructed through private donations (individual efforts). Islam is also expressed through an educational religious institute "Madrasa Azharia" (Azharia School) that caters to students at every educational level - primary, preparatory and secondary. No other religion is formally established in the community.

B. Economic Status Indicators

As is customary in Egyptian households, the senior adult male functions as household head; his social standing increases with his increasing ability to provide for his family's well-being. This is tied to his earning power and is dependent to a large extent on his primary occupation and level of formal education. For example, men with large land holdings, businessmen, and skilled craftsmen are accorded high status. They are also among the highest earners, while unskilled workers and agricultural laborers are among the lowest. Tenant farm cultivators are ranked on the basis of the size of the rented farm. The higher the level of formal education, and thus earning power, the higher the status.

Traditionally, family or household economic rank is based on objective information on economic resources such as wages, other income and savings. For a number of reasons, however, Kalamans do not disclose their personal wealth, crop yield, farm earnings and particularly, their invisible wealth (e.g. jewelry) which is held as savings. For this reason, it was virtually impossible to obtain accurate information on income and other economic resources. Consequently, economic rank was determined by assessing visible farm and household assets, a method also sensitive to social standing.

A family's socioeconomic standing is strongly indicated by the number and type of certain household possessions, e.g. a television set (then type of set - color or black and white), washing machine, wool carpet. For agricultural families, farm assets (e.g. amount of land owned) combined with household assets can accurately estimate a household or family's socioeconomic standing. Village socioeconomic structure based solely on the occupation of the lead male in the household is presented in Table 2.5. However, multiple social and economic indicators were used to determine the socioeconomic standing of households in the study sample. SES of study households is presented in Table 2.6. Multiple socioeconomic indicators for determining SES will be discussed fully in chapter 4.

C. Village Lifestyles

The astute observer is soon struck by the admixture and diversity of lifestyles in Kalama. Division of labor is strict - particularly in domestic work. However, males and females work together in the field and both are involved in family commercial activities. Women and girls are responsible for domestic duties such as child care, illness care, house cleaning, yard cleaning, dish washing, laundering, and the processing and preparing of food. These are not male ac-

tivities. Men are largely responsible for "taking care of the home" by working outside of the home and earning cash. This includes working in either the commercial or governmental sectors, in both or in one sector, plus self-employment such as petty trade or farming. Women and girls are often intimately involved in family self-employment activities such as farming and petty trade. Young boys participate in the work men do but their major activity during the school year is "going to school". This privileged status is not accorded girls who are expected to assist, if not take over, in the domestic work of women from an early age.

Women's work is usually performed in groups. Women are often seen working together at separate tasks at the canal, in their homes, and in their yards. They also work together performing identical tasks. Most domestic and some farm activities are performed in a comfortably low position on the ground, usually in a stooping or squatting position.

Agriculture is the basis of economic life; however, economic activities persist in the non-agricultural sector. In fact, the calendrical cycle in Kalama is facilitated by its diverse small-scale economic activities. There are small-scale retailers of various types, tradesmen and women, government employees, technicians, and skilled and semi-skilled service providers. A large proportion of households participated equally in the agricultural and non-agricultural sectors. Among other factors, the size of the family land holdings is often too small to permit an adequate standard of living from full-time farming.

TABLE 2.5.
Distribution of Kalama households by socioeconomic standing (SES)*

SES	Households (n=1,238)	
	n	Percent
High	395	32.0
Intermediate	452	36.5
Low	391	31.5

* SES was based on male occupation data derived from the first Kalama village census. Households were ranked as follows:

High:	Administrative, technical or professional positions -large merchants
	Secretarial and clerical jobs
	Farm cultivators (one to less than 10 feddans)
	Skilled laborers and craftsmen (own small or moderate workshops)
	Small merchants
Intermediate:	Skilled laborers and craftsmen (with no workshops)
	Street vendors (with no shop)
	Farm cultivators (less than one feddan)
Low:	Unskilled workers (non-agricultural)
	Landless agricultural laborers or sharecroppers
	Helpers in field work

TABLE 2.6.
Distribution of study households by SES

SES	Households* (n = 311)	
	n	Percent
High	45	14.5
Upper Intermediate	48	15.4
Lower Intermediate	136	43.7
Low	82	26.4

* Data missing on one study household.

D. Socioeconomic Transition and Economic Diversity in Kalama

Occupational diversity is at the heart of the rapid socioeconomic transition taking place in Kalama, and can be determined by classifying households according to the primary occupation of the household head. There are few households in which adults spend their full working time in total agricultural activities or in total non-agricultural activities (e.g. sales clerk, government clerk), although by custom, people may place themselves or they may be classified in one of these two categories. Actually, it is more accurate to classify Kalamans according to the dominant mode of activity, which may be either agricultural or non-agricultural, than to a solo activity, since most people and households are engaged in multiple activities in both the agricultural and non-agricultural sectors. This dual orientation is best captured in extended households where the two generations function in one or the other sector.

As shown in Table 2.7, over one-half (56%) of the 312 households participating in our study were non-farming families. By contrast, 21% of the sample were farmers. A similar proportion of families in the sample (23%) were employed in both agricultural and non-agricultural occupations. Data from earlier studies indicate that this type of distribution with the bulk of the sample operating in non-agricultural activities is indicative of rapid socioeconomic transformation moving to mixed occupational mode in extended families.

TABLE 2.7.
Distribution of study households by subsistence mode

Subsistence mode	Households* (n = 311)	
	n	Percent
Agricultural	66	21.2
Non-Agricultural	174	56.0
Combined†	15	4.8
Mixed‡	54	17.4
Other	2	0.6

* Data missing on one study household.

† At least two wage earners - one or more engaged in an agricultural occupation and one or more engaged in a non-agricultural occupation.

‡ At least one wage earner engaged in both agricultural and non-agricultural occupations.

As stated earlier, occupational diversity is at the heart of socioeconomic transformations. Many of the factors facilitating these transformations in Kalama are fairly obvious. The primary factors are proximity to Cairo, improved com-

munication with the outside world through transportation, travel and the communications media, availability of jobs for skilled and unskilled labor in and close to Cairo, easy access to transportation (taxis and vans), and the severe lack of housing in Cairo. The housing crisis in Cairo has led many Cairenes with or without private transportation to Kalama's modern apartment buildings. At the same time, Kalama's proximity to Cairo brings the influence of a large metropolitan city to rural village life.

Migration has had a role, also. During the 1970's, Kalama's residents took advantage of relaxed emigration laws in Egypt and migrated to other Arab countries, principally Iraq and Saudi Arabia, for higher paying jobs. Many farmers left their land to join construction teams abroad. Others with technical skills or a university education gained employment as drivers, skilled laborers, and waiters. Return migrants and emigrants still living abroad have invested their savings in commercial ventures in Kalama.

E. Cultural Stability amidst Socioeconomic Transformation

Socioeconomic transformations in Kalama do not proceed in one direction nor are they necessarily accompanied by changes in every cultural element. For example, basic cultural beliefs and values are not expected to change with a change in subsistence mode although some habitual behaviors could change as one changes his occupation. Similarly, change in values about educating girls as well as boys does not necessarily lead to immediate change in women's roles.

There are many stable elements in the culture, including those associated with gender roles domestically. Essentially, women are under the protection of men. The family head is usually a man, except in rare instances when a senior widow assumes the role of family head. The family head is the true owner of resources; he distributes these resources to household members, adults and children, as he deems appropriate. This is his right as protector and defender of the family or household. Women are responsible for all activities concerned with domestic maintenance. Women also operate in the informal market by raising poultry (pigeons and baladi or local chicken), preparing cottage cheese and farm products for sale, and selling farm products either from their homes or in the local market.

F. Current Political and Social Organization

Kalama's political, economic, and social organizations provide important links to the capital, Cairo, and to the adjacent town, Sindion. The Village Council is the major political entity in Kalama. Founded in 1963, the Council has jurisdiction over the town Sindion, the council seat, and three villages, including Kalama. Five of the 17 elected members of the Council are Kalama residents. In 1982, the Council had 163 employees, 23 percent of these were Kalamans.

The Village Council is responsible for organizing, supervising and maintaining all public sector activities such as schools, mosques, medical centers, agricultural and food cooperatives, roads, cultural centers, and libraries. The Village Council is also responsible for the development of commercial ventures such as shops, bakeries, transport services,egg hatcheries, and poultry farms. In 1982, the Village Council's budget was L.E. 92,000 (i.e. 92,000 Egyptian pounds which approximated $92,000 U.S.).

The needs of the most vulnerable residents in Kalama are addressed not by the Village Council, but by the Social Services unit whose jurisdiction and administrative location parallel those of the Council. Kalama's Village People's Committee, also founded in 1963, is the Community arm of the Social Services Unit, an affiliate of the Ministry of Social Affairs. The Village People's Committee is a membership organization with a Board of Directors. The Committee is responsible for two major community development projects - the Girls Workshop for teaching sewing to girls, and the kindergarten for children 3-5 years of age. Both require small membership subscriptions; participants' fees are supplemented by government subsidies.

The Ministry of Social Affairs sponsors and administers a Youth Center which is under the direct supervision of the Village People's Committee. The Youth Center provides a variety of recreational, educational, religious and disease prevention services to its 500 fee-paying members between the ages of 5 and 50.

Some of these activities generate income which is invested in the Center.

G. Educational Institutions

Local and national culture are inflected in the community's educational and economic institutions. For example, the Azharian Preparatory and Secondary Institute, Kalama's religious school, enrolls boys only. Girls are not permitted to attend. However, although they may attend the government preparatory school, there were twice as many boys as girls attending classes in 1982. Girls are more likely to attend the government primary school, although here, too, male attendance is higher than female.

Local educational institutions were first established in 1955. There are now five schools with educational programs for Kalama's youth - one religious primary school, two government primary schools which share the same building and facilities in two shifts, two preparatory schools -- one religious and the other government -- and one religious secondary school. The government schools, administered by the Ministry of Education, were first organized in 1955 and 1956. The Azharian primary institute was organized in 1971 to acknowledge a gift of land and building donated to El-Azhar by one of Kalama's residents. The primary schools enroll both boys and girls. The minimum age for enrolling at the government schools is five years and nine months and five and one-half years at the religious primary school. In 1982, 734 boys and 548 girls were enrolled in the government primary school, and 95 boys and 41 girls were enrolled in the religious school. Annual school fees were 125-187.5 P.T. (approx. $1.25-$1.90 U.S.) in government schools and 20 P.T. (approx. 20 cents) in the Azharian institute. Prices varied with grades in the government schools. Classroom density is high - 48 pupils per classroom in government schools and 41 per classroom in the religious school.

Pupils receive a small school lunch consisting of a package of biscuits, each day. In addition to academic subjects, primary schools provide agricultural and technical training. Sports and games are encouraged as extracurricular activities.

Kalama's government preparatory school was organized in 1975. The Azharian preparatory and secondary institute was organized in 1979. Unlike the government preparatory school, girls are not admitted to the Azharian preparatory and secondary institute. Enrollment figures in 1982 were 432 boys and 217 girls at the government preparatory school, 122 boys at the Azharian preparatory school, and 36 boys at the Azharian secondary school. For both boys and girls, enrollment declines with increasing age. Classroom density continued to be high in the preparatory and secondary schools in 1982, with 41-43 pupils per classroom in the preparatory school and 36 per classroom in the secondary schools. The annual fees increase to 350-358 P.T.'s (approx. $3.50-$3.60) in the government school, to 25 P.T.'s (approx. 25 cents) in the Azharian primary school and to 50 P.T.'s (approx. 50 cents) in the Azharian secondary schools. Agricultural training continues in the government schools, but school meals, sports activities and games, and technical training are discontinued at both schools. There is an annual contest for memorizing the Koran at the Azarian preparatory and secondary schools. Young men and women who wish to continue their education beyond that provided in Kalama must go elsewhere.

H. Economics

Kalamans play a major role in the larger economy through the marketing of their varied farm products - maize, wheat, garlic, soya beans, onions, grapes, citrus fruits, tomatoes, turnips, cabbage, cauliflower, eggplant, colocasia[2] (a variety of taro), carrots, lettuce, spinach, mulukhiyya,[3] zucchini, peppers, okra, broad beans, poultry, eggs and livestock. Agriculture is the basis of economic life, but economic differentiation is a major feature of Kalama life.

The predominant form of agricultural production is small-scale farm production. Land holdings are small but widely distributed.

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[2] Colocasia antiquorum

[3] The scientific name for mulukhiyya is Corchorus olitorius.

The land tenure structure of Kalama's farms is presented in Table 2.8. Of a total 2,867 feddans of farmland, only eight Kalamans owned between 10 and 50 feddans. The majority, 237 individuals or 39.7 percent of the village, owned one-half feddan; 29.7% rented one to three feddans; and, 26.8% of the residents owned between one-half to one feddan. The data are fairly similar for non-owner cultivators. Forty-five percent rent one to three feddans, 28.8% rent one-half feddan and 18% rent one-half to one feddan.
The land tenure structure in Kalama is probably not atypical of the region. The Egypt Reform Laws of 1969 established a legal maximum limit of land ownership to 50 feddans per person, or 100 feddans per family (Ikram, 1980). By 1975, according to the Ministry of Agriculture Statistics (Mitwali, 1981), the number of holdings of less than five feddans (2,589,000) equalled 92.5 percent of the total cultivating 67 percent of the land. The average holding was 1.5 feddan.

Farm cultivators select their crops on the basis of seasonality, profitability, marketability, access to seeds, labor availability, and the farmer's past experience with the crop. For these reasons, farms are highly productive. Principal food crops are maize, beans, some root crops such as colocasia, parsnips and carrots and a variety of other vegetables such as eggplant, okra, mulukhiyya, cauliflower, squash, tomatoes, onions, garlic and sweet potatoes.

TABLE 2.8.
Size of farms cultivated by owners and renters in Kalama, 1982.

Farm size (feddans)	Owner Cultivators (n = 597) n	Percent	Renters (n = 500) n	Percent
0.5	237	39.7	144	28.8
0.5 - 1.0	160	26.8	90	18.0
1.0 - 3.0	177	29.7	225	45.0
3.0 - 5.0	11	1.8	11	2.2
5.0 - 10.0	4	0.7	21	4.2
10.0 - 15.0	8	1.3	9	1.8

All crops are raised using flood irrigation - the only method of irrigation available in Kalama. A small irrigation canal (ahwad) feeds all the farms. One feddan normally requires approximately five hours for irrigation.

Founded in 1959, Kalama's agricultural cooperative provides credit to small farmers and helps them to market their products. Its veterinary unit provides assistance with raising livestock and poultry. Extension agents have helped farmers steadily increase their numbers of livestock since 1972.

Raw farm products flow out of the community; in return, the community receives manufactured consumer goods, and processed foods and beverages. This means that many Kalamans are involved in a variety of commercial activities which are not directly related to agriculture. Indeed, an impressive number of local entrepreneurs have launched commercial ventures in haberdashery, tailoring, shoemaking, hardware, electronics, transportation, carpentry, cabinet-making, weaving, photography, pharmacy and repair services. Other commercial ventures which are linked to agriculture and food include grain milling (maize, wheat and rice), baking and flour storage. Kalamans own sandwich shops, a restaurant, candy stores, butcheries, grocery stores, fruit and vegetable stands, medicinal plant stands, and insecticide stores.

In general then, the local economy is diverse, and Kalamans participate fairly extensively in the larger economy. However, for banking and similar economic transactions they must go to larger towns within the governorate or to the capital, Cairo.

I. Health and Medical Services

As stated earlier, the local health center dominates the landscape as one enters Kalama. The visitor is also struck by the large number of mother-child or grandmother-child pairs who patiently wait in line inside and outside of the health center to consult the doctor. The health center serves an important function in the community, despite its deficiencies in equipment and services.

The Health Center was founded in 1947 and is administered by the Ministry of Health. It is staffed by a general practitioner, two dentists, five nurses and 16 assistants serving a variety of functions. The Health Center provides both in-patient "ward" services and outpatient ambulatory services. However, the bulk of the services are rendered to out-patients for such conditions as upper respiratory infections, diarrhea and fever. Chronic conditions such as bilharzia and parasitic infestations are also treated at the health center. In 1982, the Center treated approximately 100 patients for bilharzia and 150 for parasitic infestations.

Two of the services offered at the Center have been specifically designed for children, mothers, and women of child-bearing age. One, the Mother and Child Care Center, provides birth delivery services, vaccination follow-up services and pregnancy follow-ups. Also, family planning activities are conducted in the Family "Control" Center, as it is called, locally. Approximately 50 women register for contraceptive services each month. Both programs are administered by the physician and one of the nurses.

In addition to the public sector activities described above, many health and medical services are provided by practitioners in the private sector. These include two physician-run medical clinics, two pharmacies, four lay midwives, five lay health attendants (hallak sehat), and two barbers. The local health system represents an interesting blend of traditional and more modern practitioners. Kalamans utilize both types of practitioners, depending upon the family's perceptions and needs.

J. Data Gathering Techniques

The data used in this chapter were obtained from three sources using ethnographic community-based research, a community or institutional survey, and a general survey of the village. Ethnography was used systematically through the life of the project to assess and analyze the community as a cultural, functional entity. An agricultural economist affiliated with the Nutrition Institute conducted a survey of Kalama's institutions toward the beginning of fieldwork. Social workers at the Nutrition Institute implemented two village surveys and periodic updates of the study sample. Through these multiple field strategies emerge a comprehensive picture of the research site.

V. REFERENCES

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Chapter 3

OVERALL PLAN OF THE STUDY

The Egypt project was carried out in three phases. Phase I, which began in August 1982 and lasted through September 1983, was devoted to the tasks of selecting a study community, negotiating with local officials and with village leaders for conducting the study in the community, accomplishing a village census, assembling and training a field team, and testing the feasibility of various data collection methods. Phase II, which began in November 1983 and ended in December 1985, was the period of collection of the basic data set. Phase III was a data analysis phase; these activities come to an official end with the end of the contract on September 30, 1987. However, neither time nor financial resources have been adequate to fully exploit the information in the database; major portions of it remain unanalyzed, and even those portions which have received concentrated attention for this report hold much yet-untapped information. Thus Phase III will no doubt continue for a long time for many of the CRSP investigators, even if under different fiscal and administrative arrangements.

I. PHASE I AND BEFORE

Preliminary work and planning for the Nutrition CRSP in Egypt, over the period from 1979 through mid-1982, was accomplished by the US Principal Investigators (Drs. Ron Watson at Purdue, Gail Harrison at Arizona, and Norge Jerome at Kansas) in collaboration with Dr. Hekmat Aly who was, until her retirement in June 1982, Director of the Nutrition Institute. Following Dr. Aly's retirement, there was a delay of several months before appointment of Dr. Osman Galal as Director. The beginning of Phase I of the CRSP, therefore, coincided with Dr. Galal's assuming responsibility for the Nutrition Institute. Dr. Aly remained with the CRSP as a Senior Scientist and consultant.

The first phase of the project was planned to last six months, and included the following stated objectives:

- -Selection of the study community
- -Preliminary ethnographic study of the community
- -Establishing the magnitude of inter- and intra-individual variation in usual intake of food energy
- -Characterizing the usual cyclical patterns of food intake
- -Describing the distribution of nutritional status in the community, primarily using anthropometric data
- -Describing the mortality, fertility and morbidity characteristics of the community
- -Pilot testing of methodology projected for use in Phase II, including testing of feasibility and practicability for all methods.

It was also necessary during the first phase of the project to establish administrative and working relationships among the three US universities, the Nutrition Institute, USAID, and other institutions involved in the project in Egypt; to hire and place in the field a fulltime field coordinator; to anticipate and order necessary vehicles, equipment and supplies for Phase II; to develop field manuals and training protocols; and to assemble and train the field staff.
Phase I lasted twice as long as had been planned, in large part because of the complexity of the tasks involved. The Nutrition Institute, although it had considerable experience with large cross-sectional surveys and with laboratory-based

investigations, had never before undertaken a longitudinal study with the complexity and interdisciplinary nature of the CRSP. Integrated planning, training and data management posed needs for structure and process which had not before been addressed within that institution.

The Phase I activities were able to accomplish the objectives set out above, and to conclude that: a) the village of Kalama, selected as the study site, was appropriate in terms of the distribution of nutritional status and the availability of adequate numbers of target individuals, and was a feasible community from the standpoint of community cooperation and logistics; and b) that the major CRSP variables could be measured, with some modification of methods especially with regard to food intake, in the community and under local conditions.

Phase I culminated with a three-day workshop in September 1983, held in Cairo. This workshop brought together all the Nutrition Institute and other local scientists working on the project; key US investigators, and interested individuals from the Ministry of Health and other local agencies. The background to the project and the substantive results of Phase I were presented and discussed. The proceedings of that workshop constitute the project's Phase I report, archived at Berkeley.

II. PHASE II

A. Project Administrative Arrangements and Staffing

The Egyptian Principal Investigator assembled a team of Senior Scientists from the staff of the Nutrition Institute and, in areas where the expertise did not exist within the NI, from other local institutions. These senior scientists were responsible for recruiting, training and supervising the field, laboratory, or office teams in their respective areas; and for coordination with administrative staff of the Nutrition Institute, the US field coordinator and the counterpart senior scientist in the US. Senior scientists met with the Principal Investigator, the field coordinator, and any US investigators who were in Egypt on approximately a weekly basis.

The project also formed a Ministerial-level steering committee to ensure a network for dissemination of information about the project to relevant Ministry of Health institutions and to provide guidance to the project throughout its life. This committee also served as the local responsible body for protection of human subjects. The steering committee was chaired by Dr. Mamdouh Gabr, formerly Minister of Health and currently Chairman of the Department of Pediatrics at Cairo University; members included Dr. M. M. Abdel-Kadr, Chairman of the Nutrition Institute's Council; Dr. Hosny Shehata, Secretary General of the Organization of Teaching Hospitals and Institutes; Dr. Hekmat Aly, formerly Director of the Nutrition Institute; and Dr. Osman Galal, Director of the Nutrition Institute and Head of the Child Health Department of the National Research Centre.

Four to five senior male NI staff met monthly in Kalama, after Friday noon prayers, with local leaders to review the project, discuss its impact on the village, and to aid the community in solving any problems perceived as they arose.

In the US, the Principal Investigator at Purdue, Dr. Watson, announced his resignation from Purdue University in early 1982. Dr. Avanelle Kirksey assumed the PI role at Purdue, with the concurrence of the SCB. In August of 1982 Dr. Watson joined the Department of Family and Community Medicine at the University of Arizona, where he remained active in the CRSP as a senior scientist in the area of immunology.

The three US Principal Investigators agreed to a rotational system whereby one of them would represent the project to ME and be responsible for day-to-day communication with the field staff in Egypt. During Phase II, they stayed in Egypt on a rotating basis to assist in overall project management.
The many professional, technical and support staff who contributed to the project are listed in an earlier chapter.

We were saddened by the deaths during the project of Dr. A.H. Ismail of Purdue University, Mr. Ahmed Zachariah, Senior Secretary at the Nutrition Institute, and Mr. Ali Ibrahim and Mr. Youssef of the NI's transportation staff.

B. Field Staff

Field, data management, and laboratory staff were assembled in Egypt through the resources of the Nutrition Institute. The collection of dietary data was done by NI dietitians, all of whom had master's degrees in dietetics or home economics and some of whom were working toward doctoral degrees. Anthropometric, morbidity, and physical examination data were the responsibility of the NI's "young doctors," who joined the NI as their social service commitment following completion of medical school and internship. The Phase I activities began with a staff of 19 young doctors, and a total of 57 participated in the CRSP throughout its duration. The physicians also ultimately assumed responsibility for the RMR measures, and for some major aspects of data management. Laboratory technical staff was recruited from chemists and biochemists already in the NI, and special training was provided to two doctoral-level staff in immunological techniques (one spent four months at NAMRU-3 in Cairo for this purpose and the other spent a month at the University of Arizona). Sociodemographic fieldwork was accomplished by social-work staff, who also assumed responsibility for ongoing village relationships and for followup of families who dropped from the study. The staff was to determine the families' reasons for dropping out and solve any problems which would allow their continued participation. Other activities (psychology, child care observation, etc.) were staffed by professionals from within and outside the NI selected for their particular skills and aptitudes, and from the study community itself. The Nutrition Institute designated one senior staff member to coordinate transportation arrangements, and several drivers and vehicles were assigned to the project. A full list of field staff, as well as of staff at the US institutions, is contained in an appendix to this report.

C. Selection and Recruitment Of Target Households

The census of the village accomplished during Phase I formed the basis for identification of potential target households. Previous to that census, the village was mapped and each household given a number which was painted on the door of the household. The village was divided into 12 "blocks" and households were numbered by block and individual household. Recruitment was spread geographically over the entire village; since Phase I data showed that socioeconomic variability was reflected in geographic terms, this process also provided the necessary variation in socioeconomic status.

The data management unit at the University of Kansas identified, from the census data, a list of households which would have toddlers or schoolers of the age required for CRSP enrollment at the appropriate time. A census update was undertaken at the beginning of Phase II, and completed between November 1983 and February 1984. The Egypt data management unit verified the Kansas list against the most recent census information and prepared a list of potentially eligible households. The sociodemographic field team then followed up by visiting households to ascertain actual eligibility. Households determined to be ineligible due to inaccurate age of the target child, death or divorce of a potential target or having moved from the village, were dropped from the list. Eligible households were enrolled if they were willing to participate after careful explanation of the study and what it would entail for them. Enrollments continued monthly until December 1984.

It became evident after several months that the procedure described above was adequate to recruit families of target toddlers and schoolers, but would not identify enough target pregnancies. Therefore, a plan was put in place to identify pregnancies not only from mothers of target toddlers and schoolers who became pregnant, but also from a pool of women at high risk for pregnancy, the "potentially pregnant." These were identified from the most recent census data as either a) newlyweds who did not yet have children, or b) mothers whose youngest child was more than one year of age. These potentially pregnant women were visited monthly, and their menstrual status ascertained. They were offered a pregnancy test if they were uncertain, and many accepted the offer. From the results, a list of women in the early stages of pregnancy was generated, and households were recruited.

A total of 312 households were enrolled; 258 completed the study. The attrition rate was 17.3% (54 households). Target individuals completing the study included 153 toddlers, 121 schoolers, and 124 infants. A total of 191 pregnant

women were followed (131 recruited as described above and 60 mothers of toddlers or schoolers who became pregnant during the study); the discrepancy with number of infants is because not all mothers elected to continue the study after the delivery of the infant. More complete details of the sampling procedure are described on pp. 148-52 of this report.

The recruitment of households by type of target individual is shown graphically in Figure 3.1.[1] Households remained in the study for 13 months for a target toddler or schooler, or until the target infant was six months of age. Some households, of course, were followed for longer periods of time because of the inclusion of more than one type of target (e.g., the households in which the mother of a target toddler became pregnant and then was studied throughout the pregnancy and the infant's first six months).

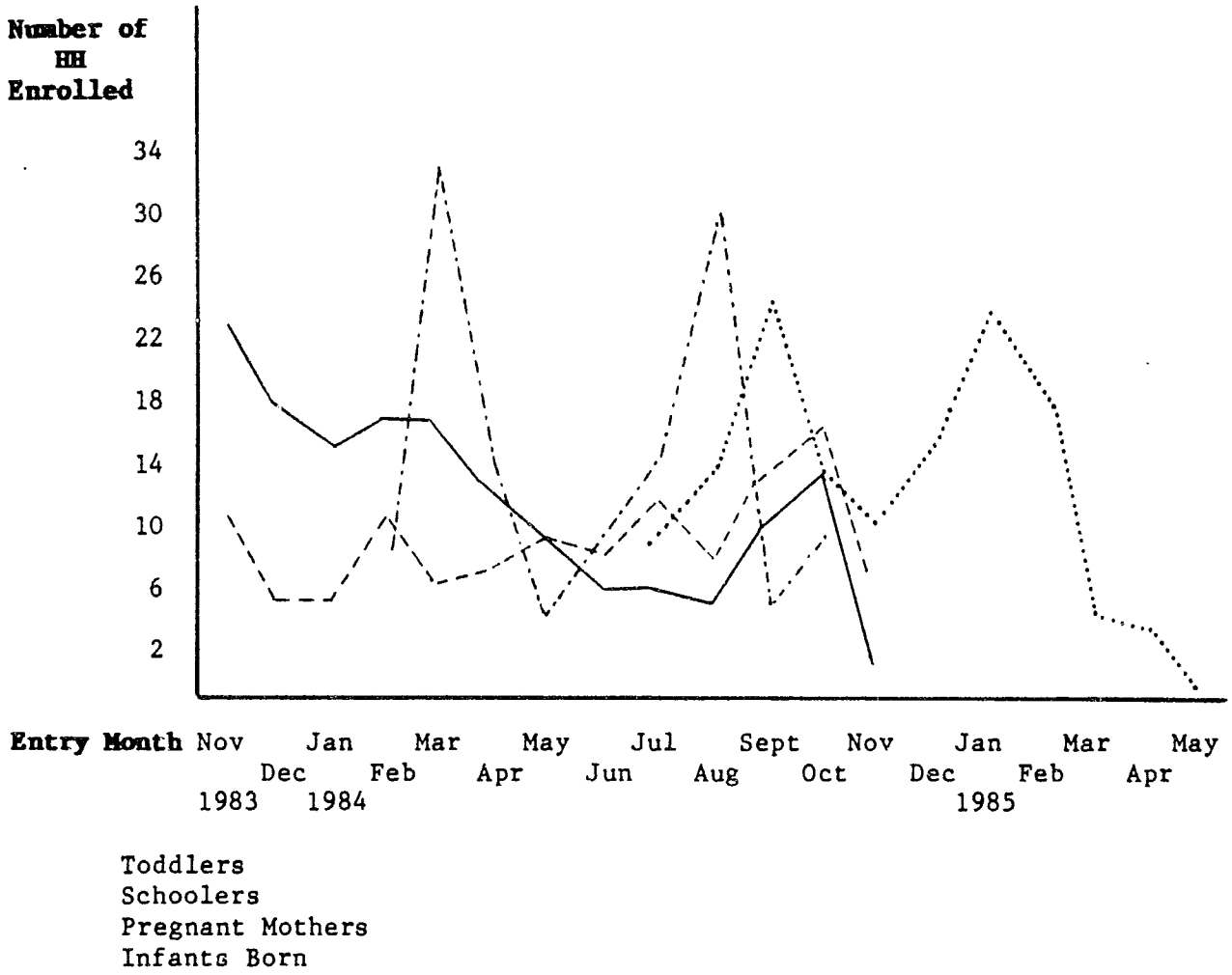


FIG 3.1. Number of core households enrolled in CRSP with target toddlers, schoolers, pregnant mothers and target infants born by entry month

[1] This figure and the figures in the preceeding paragraph are drawn from the NI's final report.

D. General Characteristics of Target Households

The target households are described in detail in Chapter II, "The Study Site." The most general characteristics are reviewed here. The size of target households ranged from 3 to 20 persons, with a mean of 7.5 persons. More than half were nuclear family structure, with the remainder being extended families.

These characteristics along with the age distribution of target household members are displayed in Figure 3.2. Figure 3.3 shows the distribution of households by subsistence type and socioeconomic status. A minority of households relied on agriculture for their living; more than 60 percent relied on a nonagricultural economic base, and about 20 percent used a mixed strategy. Socioeconomic status was generally higher in households with a mixed economic base. Literacy status of adults (determined by interview using the sociodemographic instrument) was typical of rural Egypt; slightly more than half the target males were able to read and write, but less than 15% of target females. Literacy rates overall were somewhat higher due to increased literacy rates for older children in the families.

E. Scheduling Of Field Activities

An integrated field schedule was essential to make effective use of human and transportation resources and to minimize the amount of intrusion into the lives of target households. A calendar-type schedule was designed to display all research activities to be performed in relation to each household and/or target individual each day. This schedule was planned on a monthly basis and distributed to all Senior Scientists in a timely manner so that they could organize the time of the data collectors on their teams. Since some research teams followed a schedule for weekly visits to households or on dates which required precise timing due to the age of a child, these activities were given priority when each monthly schedule was planned. Research activities which occurred on a monthly basis were scheduled next, followed by those performed quarterly. For those activities which lent themselves to specific appointment times (e.g., adult cognitive testing, RMR), the research teams scheduled their own appointments with each target individual on days which were free of other activities on the integrated schedule.

F. Data Management

The details of data management activities are contained in the chapter on that topic under Methodology; here we will give an overview of the major aspects of the system. Data management units (DMU's) were set up in the NI and at the University of Kansas. At the beginning of the project, the DMU at the NI consisted of one senior investigator and two research assistants. Later it was expanded to include two additional researchers. This unit was responsible for identifying eligible households, documenting receipt of all data forms, and verifying household and individual identification numbers; receiving and recording all change-of-status information including birth or death of a target, dropouts, etc.; training and assisting data collectors in the filling out of forms; communicating changes and problems to the field coordinator; preparing entry, exit and change-of-status forms for continuous monitoring of the sample in Egypt and the US; organizing the photocopying of data forms which were sent to Kansas; keeping account of data forms sent to the local computer center for entry, and their return; organizing and cataloging data forms; preparing summary information on an ongoing basis to monitor the missing-data situation; and processing data resolution forms sent from the US.

Because the Nutrition Institute had never before had a DMU, office space and facilities had to be acquired and organized while the above activities were being carried out. In addition, senior scientists and data collectors had to be oriented and gain experience in working with a centralized system of data management.

Until July of 1984, all raw data from Phase II research were photocopied and the copies sent to the University of Kansas for entry onto magnetic medium. Original data were kept in Egypt. This arrangement was cumbersome and expensive, and was used only until a system adequate for data entry could be identified in Egypt. Transportation of raw data forms was done exclusively by sending them with CRSP and other sympathetic travelers, in luggage or as excess luggage. Thus transportation of data and arrival in the US was uneven.

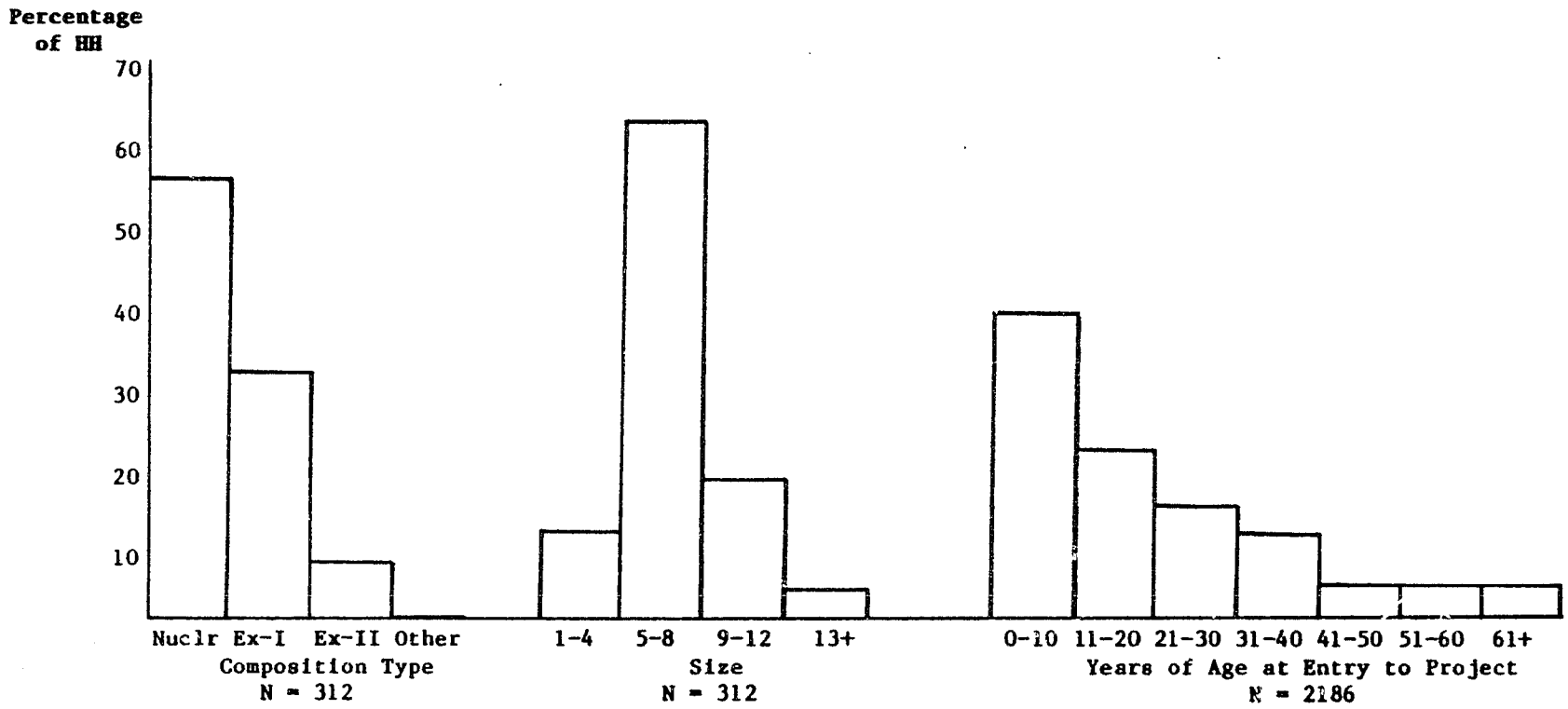
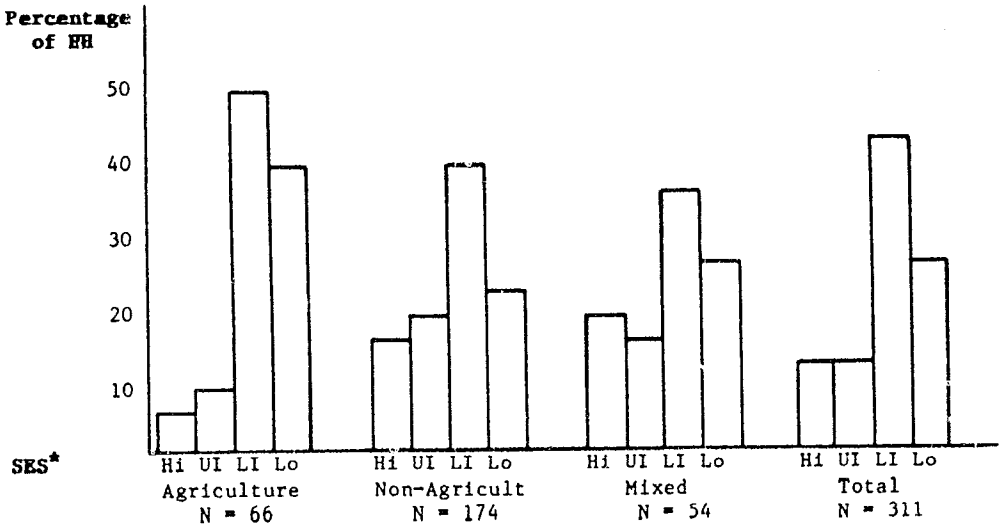


FIG 3.2. Distribution of households by composition type, size and all individuals in study by age at entry to project



*SES Abbreviations:
Hi = High
UI = Upper Intermediate
LI = Lower Intermediate
Lo = Low

FIG 3.3. Distribution of households by subsistence mode and socioeconomic status

During the first several months of Phase II, we identified a firm in Egypt which was capable of handling data entry and whose charges were reasonable. A contract was subsequently negotiated with the computer center at Al-Ahram Management Center. In July of 1984, the majority of data entry commenced in Egypt, and data were sent after that time to the US largely on tape. A few types of data (child care and time allocation) were still sent on paper for entry at Kansas. The transition was not without problems, but in the long run proved a satisfactory solution. During late 1985, the Nutrition Institute embarked on a program of upgrading its in-house analytical capability, with the acquisition of several microcomputers and training of key staff. It then became possible to enter some discrete data sets on to floppy diskette within the Nutrition Institute.

For the data entered locally (Al-Ahram and NI), range checks were applied and printouts of out-of-range values reviewed before correction and transportation (again with travelers) to Kansas. As before, the Kansas DMU continued to generate data resolution forms for questionable values; these were sent back to Egypt for resolution.

III. PHASE III: DATA ANALYSIS

Data analysis activities during and immediately after the fieldwork phase were hampered by the slow flow of data due to the cumbersome logistic arrangements described above, and by the demands of the field situation which consumed the energies of the senior investigators to a maximum degree. As larger amounts of data became available, analytical activities began at Purdue, with supportive smaller analyses taking place at the other US universities and in Egypt. The delays in receiving data and the complexity of the dataset and of administrative arrangements combined to produce a situation in which even analyses for presentation in this report had to be run on incomplete data and then rerun as the final datasets became available. Constraints of time and funding have dictated that serious analyses have been confined to those few questions which the SCB has agreed would be addressed in this report; the rest of the dataset has been documented but remains largely unanalyzed.

A major drawback of the constraints on time and funding has been that there has been limited opportunity for US and Egyptian scientists to interact in analyzing data. The project statistician, for example, has not visited Egypt during the project. We have attempted to maximize interaction by taking advantage of other trips and funding to "piggy-back" visits of several Egyptian scientists to Purdue and/or the other universities for specific interaction; one of the US PI's (Harrison) has had other opportunities to be in Egypt since the end of the fieldwork and has interacted with scientists at the NI on the subject. Local analysis of the dataset at the NI has included the work done by several staff completing MS or PhD theses. The NI has successfully garnered other support for upgrading its analytical capabilities. It now has a data analysis unit with several well-equipped microcomputers, relatively large amounts of memory, adequate data management and statistical software, and some experience with analysis; thus there should be the ability to exploit the dataset locally in the next several years.

Several MS theses and PhD dissertations have been completed or are in progress which use CRSP information. They are as follows (summaries have been archived or will be when completed):

Institution	Author	Title	Degree
Nutrition Institute	Afaf Sobhi	Food Intake and its Effect on the Child Social Behavioral Parameters	PhD
	Sawsan Abdel Ghani	Maternal Nutrition and Outcome of Pregnancy	PhD
	Emtisal Swaify	Effect of Nutritional Status on Some Psycho-Social Parameters in Primary School Children	PhD
	Salwa Makeen	Effect of Long-Term Lactation on Maternal Health	PhD
	Wagih Mawed	Pattern of Disease in Toddlers In Rural Egypt	MSC
	Wael Mahmoud	Gestational Age and Its Reflection on the Pattern of Growth in Children in the First Six Months of Life	MSC
	Mohamed Zaazou	Morbidity Burden on Toddlers' Growth as Affected by the Household Conditions	MSC
University of Arizona	Mary E. Mohs	Relation of Zinc Status to Growth and Morbidity of Egyptian Children	PhD (in process)
Purdue University	Mihira Karra	Zinc, Calcium and Magnesium in Human Lactation: A Comparison of Mineral Levels in Milk of American and Egyptian Women and Growth of Their Infants	PhD
	Anna McCullough	Relationship of Vitamin B-6 Status of Egyptian Mothers to Pregnancy Outcome and to Neonatal Behavior and Early Growth of Their Breastfed Infants	MS

IV. SPECIAL PROBLEMS AND STRENGTHS

As with any large, complex project, the Egypt Nutrition CRSP experienced unique circumstances which resulted in special problems and opportunities. Since these influence the dataset in terms of its usefulness for answering the research questions (and others which may be asked of it in the future), they will be briefly described here.

A. Special Problems

1. Measurement of Resting Metabolic Rate

The measurement of resting metabolic rate (RMR), on a quarterly basis for adults and schoolers and at specified times in pregnancy and lactation, was part of the agreed-upon CRSP protocol. This aspect of the research was plagued by a seemingly continuous succession of difficulties in the Egypt project; the investigators attempted to deal with each crisis as it arose in the most logical way at the time. Nevertheless, the situation at the time of writing this report is that we are unsure of the utility of the dataset and, although we are archiving it, will assure the reader that the RMR dataset needs further work before we can state whether it is interpretable.

The measurement of RMR did not begin with the rest of the fieldwork due to delays in arrival of the Beckman metabolic cart selected by the projects, and ultimate arrival of the cart in damaged condition. The repair technician from the company had to come from outside Egypt. The precision calibrating gases for the equipment were not available in Egypt, and although they were ordered in a timely manner there was difficulty in finding an air carrier willing to transport them from Europe. Dr. A.H. Ismail visited Cairo in December 1983 and his associate, Dr. Larry Verity, visited in March 1984 to assist in resolution of the equipment problems.

Data collection finally began in the field in July 1984 using equipment borrowed from a local research center, while awaiting repair of the Beckman cart. Analysis of results from the first months of data collection indicated that the system was not accurate; thus data collection was suspended in the fall of 1984. In the meantime, we experienced the untimely death of Dr. Ismail. In October 1984, the project hired a full-time technician, Mr. Frank Peters, who was experienced in the use of the Beckman equipment and had worked with Dr. Jed Gardiner, the US investigator in this area on the Kenya Project. Mr. Peters trained several NI physicians and senior staff in the procedures, and in the use and maintenance of the equipment. When he left in May of 1985 four medical staff members from the NI were experienced in the techniques and able to carry on data collection.

There was a further six-week interruption in data collection during spring-summer of 1985 due to the late arrival of a new supply of calibrating gases, and there were irregular interruptions throughout due to an unpredictable power supply and needs for service and replacement parts not locally available. In addition to these problems, subjects were less willing to participate in this measurement than in some other types of data collection, and in particular the incidence of refusals for second and third measurements was high.

In spite of all these difficulties, approximately 1000 tests were administered. The data, when subjected to initial analysis, yielded an unusual percentage of very high RQ values (over 1.0). Management Entity staff have worked steadily with the project's investigators to identify possible reasons for these values to arrive at a decision as to whether a correction factor or factors can be applied. At this writing, we have not resolved the situation to our own satisfaction and so are archiving the RMR data with the caveat that it must be better understood and may turn out not to be usable. We have not used it in the analyses to date.

2. Collection of Biological Fluids

There was some reluctance on the part of subjects to provide blood samples, especially in the case of young children. Some subjects who were willing to allow the collection of one blood sample refused subsequent samples. Even so, sufficient samples were collected to characterize iron and zinc status of the population. Venipunctures were much more rarely given than finger-sticks; thus the cell-mediated immunity measures were not available on a large number of sub-

jects. Saliva and breast milk samples were more freely provided, and the amount of missing data is consequently less.

3. Illness Subroutine

The Egypt Project was not able to collect the data agreed upon for the illness subroutine. The design called for frequent followup including weight, activity, and food intake data for the duration of certain illness types in target individuals. We made repeated attempts to implement the subroutine in the field, and eventually abandoned it in the late summer of 1985 as unworkable. The data collected to that time were so incomplete as to be unusable for the purpose for which the subroutine was intended. The problems stemmed from: a) overload of field staff; b) the logistic difficulties of communication of a new target illness between data collection teams within a day, given that many field personnel do not have home telephones and do not see each other every day; and c) reluctance of many households to have a family member who was ill visited as often as every other day, and subsequent antagonism of the families and risk of their dropping out of the study.

4. Mortality documentation

The Egypt Project experienced rather unexpectedly high mortality (10 infants, 4 toddlers and two adults) during the study. While these deaths are documented in the database, we were able to establish causes or probable causes in only about half the cases. Family members were reluctant to discuss the deaths, even with a sympathetic physician, and only where death occurred in a hospital, or where the previous weeks's morbidity record was informative, or the family was willing to discuss it, were we able to document probable cause.

5. Resistance to Rotation of Interviewers

We found that many families objected strenuously to quality-control measures which called for rotation of interviewers. The building of trust with an interviewer was a gradual and slow process, and when an interviewer was changed many families refused to give information, or accurate information, to a new person and worried that their trusted interviewer was being disciplined in some way. Interviewers, as well, were unhappy with the idea of rotating. We struck a compromise in each area of data collection between ideal rotation procedures and tolerance of subject families, usually by substituting other quality control measures such as observation by supervisors.

6. Cultural Constraints on Food Intake Methodology

It became clear in the early phases of the project that the measurement of food intake is a difficult and sensitive area in rural Egyptian culture. Food is an intensely private subject in this culture, fraught with connotations which make it difficult to observe and measure. In addition, there is a common focus of belief in the evil eye. The project attempted to cope with this in a variety of ways, including commissioning a focused ethnographic study by an Egyptian-American cultural anthropologist to guide our decisions. Quality control and validation procedures were particularly difficult, and the methodology worked out is described in detail in the chapter on food intake methodology. In retrospect, we now appreciate that the villagers of Kalama demonstrated their willingness to cooperate with us most clearly in their willingness to allow us to study their food.

B. Special Strengths

1. Ethnographic Study of Food-Related Issues

One of the project's most challenging problems, that of measuring food intake in a culturally acceptable manner, also resulted in one of its special contributions. Ethnographic investigation by Dr. Soheir Sukkary, complemented by the careful observation and interpretation of experience, have enabled the collection of information relative to food and related behavior which when summarized and disseminated should make an important contribution to the literature in this important area.

2. Immunology

The Egypt Project retained most of the original design with regard to immunology. On the advice of the External Evaluation Panel partway through the project, immunology was deemed the least likely piece of the dataset to contribute to answering the central CRSP questions, so when budget constraints became paramount mostly immunology was deleted. The Egypt Project was reluctant to follow this path partly because the development of a nutrition/immunology laboratory at the NI was one of the specific institution-building goals stated by the Egyptian PI. The University of Arizona's Office of International Programs provided a budgetary supplement of $10,000 to support the completion of training and laboratory development at the NI and the analysis of samples at the NI and at Arizona. As has been mentioned, reluctance to give blood samples resulted in a paucity of cell-mediated measures for children; other data are relatively more complete. The immunology data remain unanalyzed in relation to the other parts of the dataset, but are described in the Project-Specific section of this report and are available for future analyses.

3. Zinc Status

Based on other data from Egypt, we expected zinc deficiency to be a potential problem in our population. We therefore analyzed serum samples for zinc whenever enough sample remained after iron status measures, and designed the blood collection protocol to be compatible with measurement of serum zinc (e.g., acid-washed supplies). Hair samples were also collected from both toddlers and schoolers. A graduate student at Arizona is working on a dissertation using the zinc data and traveled to Egypt at her own expense to become familiar with the field situation, train field and laboratory personnel in the procedures for sample collection and handling, and has analyzed the serum and hair samples. Those data are presented in the Project Specific section of this report.

4. Breast Milk Analysis

Dr. Kirksey's interest in breast milk composition has led to the analysis of milk samples for fatty acids, zinc, and pyridoxine. Briefly, these analyses showed fatty acid patterns quite different from those of comparable US women, high in the monounsaturated fatty acids which indicate a substantial portion of milk fatty acids coming from mammary synthesis; a lack of response of milk zinc to controlled supplementation; and low levels of breast milk pyridoxine in a significant number of mothers. The latter finding has resulted in a separately-funded investigation now taking place in Kalama into the functional consequences for the infant of low pyridoxine content of milk.

5. Behavioral Observations of Child Care, Time Allocation and Sanitation

Nutrition Institute personnel were trained in techniques of ethnographic behavioral observation and applied these measures of child care, time allocation, and sanitation. Most important, perhaps, was the involvement of village residents in developing protocols to observe and record customary behaviors.

6. Institution Building

Coming as it did at a time in which the NI was adjusting to new leadership, the CRSP provided the opportunity for substantial strengthening of the Nutrition Institute. While not solely responsible for the many positive changes which have occurred in that institution in the last several years, the CRSP provided a focus for constructive interaction; a sense of camaraderie among a diverse group of scientists; and the opportunity to develop not only a precious and valuable database relevant to national health concerns but also long-lasting collaborative relationships between Egyptian and US scientists.

Chapter 4

METHODS

I. FOOD INTAKE

A. Research Goals and Objectives

Food intake is the primary independent variable to be measured in the research. Therefore, the four main goals of the dietary research were to: 1) obtain valid and reliable quantitative estimates of amounts of foods and beverages consumed by key individuals and households during a consecutive 12-month period, 2) accurately record and code the dietary information on data collection instruments designed specifically for this research activity, 3) develop a food composition data base with all foods which are major sources of food energy and key nutrients, and 4) convert the raw food intake data to energy and nutrient values. These project goals complemented Nutrition CRSP program goals ensuring that our data could be used for comparison across projects with confidence, and would be adequate for characterizing the food intake of target individuals and households.

The project specific objectives to achieve the above goals were to 1) obtain quantitative data on the total amount of food consumed by the target woman, target man (when available), target toddler, and target school-age child two consecutive days per month for 12 consecutive months, 2) obtain quantitative estimates of household food intake on the same two days per month as the individual targets, 3) obtain quantitative estimates of all supplementary foods fed the target infant.

The research activities were divided into two phases in order to characterize the sequence and type of research activities in the study. Phase I food intake research was conducted from October 1982 to October 1983 to develop and test methods for implementation in Phase II which began in November 1983 and ended in December 1985.

B. The Sample

Phase II research was conducted on a sample of 312 households consisting of the following target individuals:

- 258 adult females:
  - 133 of these were pregnant
  - 102 of these breast-fed their babies
- 258 adult males, husbands of target females
- 150 toddlers, 18-30 months of age
- 126 school age children, 7-9 years of age
- 104 infants up to 6 months of age

C. Developing Food Intake Methods During Phase I

Preliminary research activities on food intake were conducted to determine the following:

- o appropriate approaches to food intake studies in Kalama, Egypt
- o the degree and nature of variation and stability in the food intake of Kalamans
- o feasibility of performing household food inventory studies
- o food intake patterns during the Ramadan fast and two main feasts

1. Approaches to Food Intake Studies in Kalama

A preliminary study on food consumption by individuals was conducted in Kalama in April 1983. In addition, nutriethnographic studies on local food consumption practices were conducted from October 1982 through October 1983. The ethnographer participated in community life and observed and recorded the intricacies of food traditions, food habits, and the rituals associated with food and drink, feeding, eating, and drinking.

a. Methods - April 1983

The goals of the April 1983 pilot study were to: 1) obtain a preliminary profile of the food intake of Kalamans and to characterize the sample by dietary pattern, 2) obtain quantitative amounts of foods and beverages consumed by individuals residing in households of varying SES in the 24-hour period preceding the dietitian's visit, 3) calculate the total energy content of the foods and beverages consumed by each respondent, and 4) compare the individual's energy intake with the WHO/FAO Recommended Dietary Allowance (RDA) for energy.

A representative sample of 63 households was selected from an original sample of 200 households participating in preliminary sociodemographic and anthropometric research. The sample included women of child-bearing age, their husbands, school-age children (9-12 years of age) and preschoolers of approximately 2 years of age.

The dietary survey team consisted of 20 staff researchers at the Egypt Nutrition Institute who had participated in a three-day training program on 24-hour dietary data collection procedures combining short-term recall and weighing, designed especially for the survey. The training program consisted of two days of didactic work and one day of practical experience in classroom data collection, described in detail in the Phase I Food Intake Manual.

In Kalama, the trained dietitians interviewed target adults and school-age children on their previous day's food intake. Mothers reported for preschoolers. Dietary data were collected on each individual on three non-consecutive days in a nine-day block, i.e. with consecutive days between each interview. Friday, the legal holiday in Egypt, was included for approximately half of the households studied.

Dietitians followed the instructions described in the Phase I Food Intake Manual. They obtained oral reports on foods and beverages consumed by a target individual at each eating event. These were recorded on the dietary interview instrument in sequence beginning with the first eating event, "breakfast," and continuing with each subsequent eating event until all events were recorded. Amounts consumed at each eating event were determined by a combination of measuring and weighing. Food and beverage amounts were first measured using the respondent's household utensils. These amounts were then standardized with the dietitian's measuring kit and weighed on her portable scale. Data were then recorded on the food intake instrument as grams consumed.

Recipes of mixed dishes were obtained for calculating the mixture's energy content. Information on the type and amount of each ingredient, its physical state before preparation (e.g. canned, dried), and preparation functions were recorded separately.

Total energy content of foods and beverages consumed by the individual during the 24-hour period of study was derived using the following procedure:

i. Identifying "equivalent" food and beverages items in the Egypt Nutrition Institute's Food Composition Tables.

ii. Determining kcal content of each dietary item recorded, based on the gram weight of each item "as purchased" or before its preparation for consumption. This step required the conversion of the gram weights recorded for the edible portion of the food item into the gram weight of the food "as purchased," e.g. dividing the weight of cooked legumesby three and cooked cereal grains by two.

iii. Adding all kcal values derived from foods and beverages recorded on the individual's food intake record.

b. Implication and Application to Phase II Research

Modifications of food intake methods for Phase II research activities were based on the following findings:

i. The Kalama dietary pattern mirrors the traditional diet of rural Egyptians. Bread made from wheat and corn is the primary food staple. It is consumed by all individuals and accounts for most of the calories consumed each day by target individuals. Other principal components of the dietary pattern are sugar, fava beans, home-made cheese, rice, and stewed vegetables. Meat is consumed infrequently.

ii. Food distribution is not individualized; this challenges the investigators to devise a method or methods for obtaining valid data on the food intake of individuals. Meal consumption at home is a very private, communal, family affair. The family sits on the floor around a tablaaya (low table) with bread in lap and prepared dishes on the tablaaya. Each person, including the toddler, serves himself by scooping an item such as vegetables, beans, or meat with a piece of bread before conveying the food to the mouth. Rice sometimes replaces bread to convey other food to the mouth; rice may also be eaten without an accompanying relish.

iii. Women and girls are fully responsible for food preparation.

iv. The energy intakes of individuals in three target groups -adult males, adult females, and children of school age - did not significantly differ when stratified by SES; the intakes of preschoolers differed only slightly.

v. Few adults and 9-12 year old children fell below 60% of the WHO/FAO RDA for energy. However, the majority of the toddlers in all SES categories had intakes below that level.

vi. Dishes are often prepared for consuming on two consecutive days. Samples of prepared food were generally available for sample weighing.

vii. A limited number of target males were available for reporting on their food intake.

Phase I dietary methodology was reviewed and evaluated for accuracy in data collection, recording, and analysis. Several major modifications were made for implementation in Phase II:

i. Five new data collection instruments were designed specifically to meet the research objectives of the Egypt Nutrition CRSP. These were developed in English, translated into Arabic by a bilingual investigator, and then back-translated to English by a different bilingual investigator.

ii. A 6-digit food coding system was developed to ensure accurate and specific recording of dietary items.

iii. The food intake manual was revised to standardize field data collection techniques and to serve as an important guide and reference to the food intake data collector.

iv. A schedule of male's work and availability at home was developed to ascertain the best time for obtaining the target male's self-report on food intake.

v. The procedure for collecting food intake data was reformatted as follows: Obtain information on food intake by determining, 1) the types and amounts of raw foods prepared, then the amount of prepared food served communally, 2) the number and identity of those eating communally, to be followed by an estimate of the amount consumed by the target female, and 3) an estimate of the amount consumed by others present relative to that consumed by the target female. Finally, whenever possible, verify the information reported by the target female with other available targets, i.e. adult male and school-age child. Obtain recipes for all mixed dishes. Given the tradition of communal eating, this semi-quantitative food intake method was considered an appropriate approach to securing good estimates of individual food intakes.

2. Estimation of Inter and Intraindividual Variation in Phase I Food Intake Data

The reliability of the food intake collection technique is an important consideration in determining the ultimate validity of the data. In addition, the investigator must also understand the inherent sources of variation in the study population's energy intake. The extent of measurement error inherent in data collection, combined with the true daily variation in intake by the same individual, must be determined before selecting the appropriate research method.

Variation in usual intake among individuals (interindividual), and over time for any single individual (intraindividual), contribute to the sample population's total variation in estimated mean energy intake. The food intake research methods implemented in the study must reduce to a minimum the effect of intraindividual variation in food intake, in order to effectively examine the relationship between an individual's usual intake and a specific function. The following analysis was conducted to determine the range of inter- and intraindividual variability in energy intake of Kalamans.

a. Methods

Individual food intake data, collected during the April 1983, pilot study were used in the analysis. Interindividual and intraindividual variation in energy intake on a sample of adult men (n = 34), adult women (n = 34), school-age children 7-10 years of age (n = 34), and other children from two months to two years of age (n = 34) were derived using a simple analysis of variance (ANOVA) on sets of three one-day mean energy intakes. Coefficients of variation (CV) were determined for each group of target individuals.

i. Intraindividual Variation

The intraindividual CV was approximately 20% for each group of target individuals in this analysis. The magnitude of this error is less than the 25% found by Beaton et al. (1979) in an analysis of 24-hour dietary recall data on adults living in Toronto.

Using the results of Beaton et al. (1979) as an estimation, a decision was made to estimate usual intake in Phase II by pooling six independent observations representative of an entire week over a three month period. This sampling procedure would yield what was judged to be an acceptable error, i.e. error in estimation of individual's daily intake, of approximately 10%.

ii. Interindividual Variation

Interindividual CVs were approximately 16% for adults, 20% for schoolers, and 45% for other children. The estimate for adult Kalamans suggested that this population could be slightly more uniform in mean energy intake per day than the Toronto population (CV = 25%) (Beaton et al., 1979). A decision was made to increase the range of adult energy intakes through appropriate sampling strategies in Phase II.

The interindividual CV for children two months to two years of age (45%) suggested a large variation in the energy intake. This could be largely explained by the data collection procedure of recording only non-breast milk intake when both breast feeding and complementary feeding occurred. The interindividual CV could be a measure of the range in stage/extent of weaning and not really a reflection of the range of total intake. Consequently, the true range of their food intake, including both breast milk and supplementary foods, remained unknown.

Additionally, the ANOVA suggested that there could be a sequence effect, i.e. a systematic change in reported intake with successive days of reporting for infants and to some extent, older children. Caretaker reporting or caretaker-interviewer interactions during reporting could be contributing some degree of progressive bias. Although indications were not strong, data collection methodology was reviewed to minimize any chance of systematic effects.

3. Determining the Feasibility of Performing Household Food Inventory Studies

Abdou and Moussa (1975) had tested the feasibility of the household food inventory method in an Egyptian village earlier. They found that the food inventory method used concurrently with other food data collection methods was impractical for data collectors and too time-consuming for the respondents. In addition, data could not be obtained from some economically advantaged families and from families living a hand-to-mouth existence. High SES families resisted fieldworkers' requests to declare quantities of stored food, while low SES families had none to declare.

An attempt was made to implement the household food inventory method in a pilot study. After a few trials the method was abandoned due to poor cooperation by all households. Like other rural Egyptian households, Kalama households abhor the display of material possessions, including food, to nonkin for fear of the "evil eye," i.e. bad luck brought about by "envious eyes" or by the gaze of observers or onlookers. Essentially, the household food inventory method is absolutely not congruent with the local culture and had to be abandoned.

a. Methods

Household food intake for a 24-hour period was estimated concurrently by two different methods in 20 households: 1) oral report by target female using a combination of 24-hour recall and sample weighing, and 2) the household food inventory. Both methods were administered in each household. A different dietitian was responsible for collecting the data for each method.

Dietitians using the 24-hour recall and sample weighing method followed the procedure described for the October 1982 and April 1983 studies.

Household food inventories were conducted on two consecutive days according to the following procedure: On the morning of Day 1, the data collector/dietitian interviewed the target female and weighed and recorded the amounts of all foods and beverages in the house for household food consumption. Large supplies, such as cereals, cheese with mish (butter curds), onions, and garlic which could not be weighed on the dietitian's portable 10 kg. scale were estimated by the dietitians or target female. All dietary items were recorded in gross weight as acquired. On the morning of Day 2, all available food stores in the house were again identified, and foods and beverages weighed and recorded. The dietitians also obtained information on the food and beverages added to the household food supply on Days 1 and 2 (after the dietitian left and before she returned), and on all dietary items which exited the household food supply during the interim but were not consumed by household members. The weights of these foods and beverages were determined and recorded. Dietitians also recorded the channel of food entry and exit from the home.

The household's apparent food energy consumption was calculated, and the data were compared to the kcal value derived from the 24-hour recall and weighing method. Energy content of foods and beverages consumed were calculated as previously described in Section C.1.a.

The following formula was used to calculate household food intake from the food inventory data.

Household Intake = (A + B) - (C + D)

Where A = Energy content of household food supply on Day 1

B = Energy content of foods and beverages entering the house on Day 1

C = Energy content of household food supply on Day 2

D = Energy content of food and beverages exiting the house on Days 1 and 2 that were not consumed by household members

b. Implication and Application to Phase II Research

Several important results were derived from this pilot study:

i. Household food intake as determined by the 24-hour recall and household food inventory methods was similar for most food items and for most households

ii. The household food inventory method was very time consuming - each household required approximately eight hours of the dietitian's time.

iii. Most households were uncooperative when dietitians requested to weigh quantities of stored food; 25% refused.

iv. Households did not reveal all their food, particularly poultry and items stored on the roof. Many stated that they feared the evil eye.

v. Families refused to allow dietitians to weigh or even count their bread.

vi. Some households of lower SES had no food stores.

vii. Target females would not allow dietitians to check their food rations book.

Based on the results of this pilot study, the decision was made not to implement the household food inventory method in Phase II. Instead, a modified version of the individual food intake instrument was developed which also included information on the dynamics of household food flow and was designed for implementation during Phase II.

4. Determining Food Intake During the Ramadan Fast and Two Main Feasts

To complete the profile of the dietary pattern and food intake of Kalama households and individuals, a pilot study was designed for collecting food intake information during the Ramadan Fast and Ramadan and Biram Feasts of 1983.

a. Methods

Food intake data were collected on each of four target individuals in 30 households. Data collectors followed the same procedure used in October 1982 and April 1983 for collecting data on one day's food intake.

Because eating patterns change during these Moslem religious observances, this pilot study's data collection schedule was modified from the October and April studies. The period of study during the Ramadan fast was seven days. Food intake data were collected throughout the month of Ramadan. Data collection was scheduled on the following days:

- Saturday, Sunday and Monday during the first 10 days of Ramadan
- Tuesday and Wednesday during the middle 10 days of the month
- Thursday and Friday during the last 10 days of the month

Data were obtained on foods and beverages consumed during the three-day Ramadan and Biram Feasts. Individuals were interviewed via "long-term recall" on the first working day following the last day of the Feast, to determine what and how much they consumed during these periods.

b. Implication and Application to Phase II Research

Results of this pilot study indicated that the food intake of households and their individual members during the Ramadan fast did not require an alternate strategy for obtaining dietary information. Consequently, the special data collection procedure used in this pilot study would not be implemented during the Ramadan fasts of 1984 and 1985. (We presume that respondents find it easier to remember special foods made especially for ritual and ceremonial occasions, than to recall everyday foods consumed routinely.)

The "long-term recall" method used for data collection in this pilot study yielded reliable data on household and individual food intake during the Ramadan and Biram Feasts. Therefore, a decision was made to use this method for collecting data during the Feasts of 1984 and 1985.

D. Food Intake Methods Implemented in the Final Research Design

The final methods implemented during Phase II are described in this section. Data collection began in October 1983 and continued until December 1985. The data were processed and summarized for testing the basic hypotheses of the Nutrition CRSP.

1. Methods of Collecting Data on the Daily Food Intake of Households and Individuals during Periods of Usual Consumption and Moslem Religious Observances

The general methodologic approach (unchanged from Phase I trials) combined probed oral self-report and sample weighing to obtain complete and accurate quantitative data on individual food and beverage intake during two consecutive days each month for 12 consecutive months, and to obtain reliable measures of household food intake for the same reporting period. On each day of the 2-day recording period, the target female was asked to report on the dietary items and mixed dishes consumed by household members the previous day. Information was requested by eating event, in sequence, including a record of each individual present for each eating event. For mixed dishes prepared in the home, the amount of each ingredient in the recipe was obtained, the weight being recorded in the pre-preparation state. If the mixed dish had been purchased ready-to-eat, the amount of recipe ingredients was estimated from a file of commercial recipes for this village market. As noted above, portions of mixed foods consumed communally were estimated by the target female for herself and for others as a proportion of her own intake. Supplemental data on the physiologic condition of household members was also obtained by interview. Specific methodologic procedures for each aspect of the research are described below.

a. Household Food Intake during Periods of Usual Consumption

The data set required in the CRSP research design called for the collection of six days of food intake information on households every three months. To meet this need, food intake data were collected on each study household on two consecutive days each month. The original schedule implemented in October, 1983 specified a seven-day week every three months; this was changed to the more practical six-day week per three months in March, 1984.

Household food intake and the food intake of target individuals were on the same two days every month. Using a combination of "recall" and weighing, a record was made of all foods and beverages consumed by household members at home or away from home, if obtained from the household food supply. (Supplementary information on household

food dynamics, i.e. the flow of food into and out of the home, was obtained while collecting data on household food consumption.)

A census of household members eating from the household food supply during the recording period, and the physiologic status of the adult females were also obtained.

b. Individual Food Intake during Periods of Usual Consumption

The data set required in the CRSP research design called for the collection of six days of food intake information on key household members every three months. To meet this need, food intake data were collected on each study subject on two consecutive days each month. The original schedule implemented in October, 1983 specified a seven-day week every three months; this was changed to a six-day week per three months in March, 1984.

Target females, males, and school-age children were interviewed personally when available. Target females supplied supplementary information for these individuals as needed, particularly for the target male.

Quantitative information on the target toddler was obtained from the child's caretaker(s), usually the mother. Other individuals such as an older sister, grandmother, aunt or other caretaker were also probed for information on the child's food intake.

When the target male or the target schooler were present in the household but not available for interview, their within-household food intake was determined by interviewing the target female.

Information on foods and beverages consumed away from home was also obtained from each target individual. Food values for mixed dishes consumed away from home were determined from "standard" reference recipes collected in Kalama during Phase I.

c. Special Consideration for Collecting Food Intake Data during Ritual Fasts and Feasts - Ramadan and Biram

During the two main feasts, Ramadan and Biram, food intake data collection proceeded according to the schedule tested during Phase I trials. Usual field schedules were suspended during these Feasts and resumed immediately thereafter. Dietary information for days 1 and 2 of the Feasts were obtained via "long-term recall" on the first working day following each Feast. Dietary intake data were supplemented with household recipes for festive mixed dishes prepared and consumed during the three or four Feast days.

2. Methods of Continuing Validity Trials - Quality Control

Despite the recognition that displaying food to outsiders was unacceptable to Kalamans, a validation trial was undertaken to observe and quantify the foods consumed by individuals during family meals. This observational technique was employed on 22 core households in order to compare the data obtained by observation with those obtained by short-term recall and sample weighing. Data were collected on the same households for the same dates and periods of time by different investigators; local observers who were related to the respondents obtained their information by observation and Nutrition Institute dietitians, via the 24-hour recall and sample weighing method.

Another validation study was implemented on 105 randomly selected core households to compare the data obtained by the short-term recall method with the regular 24-hour recall plus sample weighing procedure. The two recall procedures were administered by two different dietitians who collected, recorded, transcribed, and processed the data independently of each other.

Two other major quality control procedures included: 1) periodic analysis of interviewer reliability and 2) continuous analysis of means and variances of energy intake.

3. Method of Collecting Food Intake Data on Indication of Altered Intake during Illness

Data collectors departed from the usual two days per month cycle of food intake data collection when there was indication of an individual's altered intake during illness. Fieldworkers responsible for collecting morbidity information notified their field supervisor when they determined that an individual's food intake had changed from their "usual" pattern. The food intake data collection supervisor was then notified to dispatch a dietitian to this home.

Following the prescribed food intake data collection protocol, the dietitian determined what and how much the sick individual consumed during the previous 24-hours. This information was recorded on the individual food intake instrument.

E. Development of the Food Composition Data Base

The food composition data base provides data on energy and nutrient values for key Egyptian foods and beverages.

1. Goals

a. To develop and make available to the project a food composition data base which includes all foods which are major sources of food energy in the study communities.

b. To provide the following food composition information on the foods which had been identified as major sources of food energy: water, ash, crude fiber, nitrogen, total fat, utilizable carbohydrate, total carbohydrate, carotene, vitamin A, protein, calcium, iron, sodium, thiamin, riboflavin, niacin, and ascorbic acid.

2. Methods and Procedure

Information on food energy and other nutrients were carefully and systematically selected from several primary reference documents. The following publications were consulted in the priority order described below:

- First, FAO Food Composition Tables for the Near East (1982) were consulted because they were expected to contain the most accurate food composition data on Egyptian foods, in both the "edible portion" and "as purchased" states.

- If a dietary item were not found in these tables, the next reference selected was the FAO Food Composition Tables for Use In East Asia (1982).

- If data were still unavailable, Bowes and Church's Food Values of Portions Commonly Used (1980) could usually provide data on the food item itself or a very close occidental facsimile.

These three references provided the bulk of information in the data base.

- Additional sources used in constructing the food composition data base were the Egypt Nutrition Institute's food composition tables, laboratory analyses performed by Medallion Labs, University of Minnesota and a local commercial Tucson, Arizona laboratory, secondary references cited in the Egypt Nutrition Institute food composition tables and interpolations based on other documented values.

Sources for all values have been fully documented.

3. Energy Composition Data Base

The following five columns of information are provided for each food or beverage item recorded in the field manual, Food Codes for Use in Egypt.

- The name of the dietary item, including the state as consumed
- A four-digit "food item" code representing the food or beverage item
- Each dietary item's two-digit "state of food" codes which appear in the household and individual food intake records
- Energy content in the edible portion of 100 grams of each dietary item in the "as acquired" or "as purchased" state.
- Reference for kcal data.

4. Nutrient Composition Data Base

The following 25 columns of information are provided for each food or beverage item recorded on household and individual food intake records.

- The name of the dietary item, including the state as consumed
- A four-digit "food item" code representing the food or beverage item
- Each dietary item's two-digit "state of food" codes
- An "edible portion" factor for converting food intake data recorded in grams "as purchased" into grams of "edible portion" consumed. This factor was derived by subtracting the percent refuse from 100. Grams of food recorded "as purchased" are multiplied by this factor to obtain its "edible portion."
- Fifteen nutrient or food component values for 100 grams of the edible portion of each dietary item. The following constitute the 15 nutrient/food component values:

  - water (grams)
  - protein (grams) Animal and plant sources are separated.
  - fat (grams) Animal and plant sources are separated.
  - total carbohydrate (grams)
  - calcium (milligrams)
  - iron (milligrams from animal and plant sources separated)
  - sodium (milligrams)
  - thiamin (milligrams)
  - riboflavin (milligrams)
  - niacin (milligrams)
  - vitamin A (retinol equivalents and micrograms of retinol)
  - vitamin A precursor (retinol equivalents and micrograms of B-carotene)
  - vitamin C (milligrams)
  - crude fiber (grams)
  - ash (grams)

- Reference for food composition data.

Construction of the energy composition data base is based on the assumption that the energy content of a pre-prepared or uncooked food item, with no added ingredients such as fat and oil, is equivalent to the energy content of that item prepared or cooked. Based on this premise, energy-yielding nutrients (protein, fat, and carbohydrates) also show no difference between cooked and uncooked states in the nutrient composition data base.

Vitamin and mineral losses from cooking, however, are accounted for in the nutrient data base. Vitamins and minerals contained in the cooked dietary item were determined by multiplying the amount contained in the raw state by a standardized percent, reflecting nutrient retention after cooking under optimum conditions, e.g. shortest cooking times to attain doneness. These percentages were obtained from the United States Department of Agriculture's Provisional Table on Percent Retention of Nutrients in Food Preparation (1984).

Please note the following special procedure for determining the level of beta-carotene in prepared foods. The USDA publication used for determining nutrient retention in food preparation does not contain specific data for beta-carotene losses. However, data for vitamin A are presented. To avoid missing data on beta-carotene content in prepared foods, the available data for vitamin A retention were used.

In another special situation, food composition data on all meats, poultry, and meat products are presented in the raw state only. This decision was made for the following reason. Food intake data collectors recorded weights of meats, poultry and meat products consumed in the raw or "as purchased" state, i.e. grams of fat, bone, skin, feathers, etc. were included in the weight. Unlike the components of other food groups (e.g. fruits, vegetables, eggs) which have relatively standard amounts of inedible portions, the percent refuse for components of the meat, poultry, and meat products food group can be quite variable. This is due to potential net weight losses from drippings, volatiles, etc. depending on length of cooking time, method of preparation, cut of meat, etc. Therefore, to avoid introducing error and bias in the data base by guessing at weight losses, food composition data for the dietary items in this food group were recorded in the raw state only.

Overestimation of nutrient retention is possible due to styles of cooking for long periods of time, i.e. "stewing" vegetables, periodic reheating of cooked dishes to prevent spoilage, and recooking the "next day portion" of day-old prepared dishes just before eating. On the other hand, all liquids produced during cooking are customarily consumed.

5. Deriving Food Composition Data for Composite Foods and Beverages from Recipes

At the time of writing this report, the Egypt project is completing the final food composition table. There are known problems with the earlier food composition table which was used to calculate nutrient values used in this report. The major error affected energy values only. Therefore, the analyses presented in Chapter 5 are based on energy intakes calculated from protein, fat, and carbohydrate intakes, using the general energy factors of 4 kcal/g for protein and carbohydrate, 9 kcal/g for fat. The final corrected food composition table will be incorporated into the archive.

Energy and nutrient composition data for the following 11 composite Egyptian foods and beverages were calculated from general recipes supplied by Dr. Nargis Bassily of the Egypt Nutrition Institute. Refer to pp. 60-62 for a description of each food item, its ingredients, and method of preparation.

- sahlab
- shih
- rehydran
- fetir meshalted
- besisa
- basboussa
- fetir
- mafrouka
- dokka
- kataif
- mishabek

The food composition data base provided information on energy and nutrients (protein, fat, total carbohydrates) for the ingredients in each recipe. Many ingredients lacked information on minerals and vitamins; therefore, they were ex-

cluded from the validation study. All calculations were performed using energy and nutrient contents in 100 grams of the edible portion of each dietary item.

Food composition data for each recipe were calculated by totaling the sums of their ingredients. Total weight of the "raw" composite food was adjusted (if necessary) to reflect net changes in weight due to preparation methods, e.g. decrease due to drying in baking and increase due to fat absorption during frying. The United States Department of Agriculture publication, Food Yields Summarized by Different Stages of Preparation, was consulted for data regarding weight changes.

Finally, the proportion of the energy, protein, fat, and total carbohydrate content in the whole recipe was taken to reflect the content in only 100 grams of the food or beverage.

6. Validation Method

Individual food intake data and concomitant 24-hour composite dietary samples were collected on seven Kalamans of different age, sex, and physiologic state (females only). The following individuals were included.

- adult male
- non-pregnant and non-lactating adult female
- pregnant and non-lactating adult female
- non-pregnant and lactating adult female
- pregnant and lactating adult female
- school-age child
- toddler

For each sample, the University of California - Berkeley compared energy, protein, fat, and total carbohydrate values derived from the individual food intake data, using the food composition data base against the results of proximate analyses performed by the University of Minnesota.

Energy values were computed for both the data base and lab analysis, using the 4 9 4 energy equivalent factors and values reported for protein, fat, and total carbohydrate, respectively. Some foods listed in the sample diets were missing nutritive values in the data base. Nutrient compositions for these foods were left blank and calculations were performed without them.

Table 4.1 presents a summary of the results of this comparative analysis.

Table 4.1.
Summary of percent differences - food data base vs. lab analysis values

Sample	Percent difference*			
	Protein	Fat	Carbohydrate	kcal†
Adult male	-11.6	11.5	-13.7	-9.1
Non-pregnant non-lactating	10.2	97.7	-5.9	13.9
Pregnant 9 months	18.7	57.0	2.3	19.1
Lactating 7 months	-5.6	11.5	1.3	2.2
Pregnant 4 months and lactating 15 months‡	63.9	252.7	59.6	91.4
School-age child	24.1	63.9	28.0	31.3
Toddler	-7.2	-2.5	-16.1	-12.1
Mean difference	13.2	70.3	7.9	19.5

* Percent difference is expressed relative to Medallion Lab values.

† Kcals determined using 4 9 4 energy equivalent factors.

‡ Possible error in sample preparation for analysis.

F. Descriptive Statistics and Summary of Findings

The mean energy and nutrient intakes for adult males, adult females, school-age children, and toddlers ranked according to SES are presented in Tables 4.2-4.7. Individual food consumption data were obtained on individuals in 312 Kalama households. Sample sizes indicated in the tables refer to total number of observations, including target males with incomplete data sets. Both breast-fed and nonbreast-fed toddlers are included in the sample. The energy and other nutrient values are based on an early version of the Egypt project food composition table prior to changes and corrections.

Wide variation in level of food intake as indicated by the large standard deviations presented in these tables imply that no statistically significant differences exist in mean intakes of target groups across SES levels. However, the data suggest the following trends when consumption is linked to SES.

i. Mean kcals per day (Table 4.2) consumed by individuals in the high SES group are greater than in all lower SES groups. The low SES group is next followed by the lower intermediate group and finally the upper intermediate group.

ii. Data on mean animal protein (Table 4.3) and animal fat (Table 4.5) consumption per day suggest a direct relationship between consumption of animal products and SES, i.e. consumption of animal products increases with SES.

iii. Data on mean plant protein (Table 4.4), plant lipid (Table 4.6), and carbohydrate (Table 4.7) consumption suggest a less well-defined trend. However, for each food component, mean intakes are lowest for all individuals in the upper intermediate SES group. The highest mean intakes are consumed by adults in the low SES group and children in the high SES group with the following exception; schoolers' mean plant lipid intake reflects the adult pattern.

These results are consistent with expectations. Egyptian government policy heavily subsidizes food assistance programs.

Theoretically, the food ration system and government food cooperative store are designed to benefit those in the lowest economic levels by supplying them with commodities that are generally available only to those with adequate economic resources.

All Kalama residents with a government identification card are issued a food rations card and thus, are eligible for purchasing dietary staples such as tea, rice, sugar, and oil, at fully or partially subsidized prices. Likewise, all Kalama residents are free to shop at the government food cooperative where they can purchase items such as frozen beef, chicken, fish, legumes, and pasta, also at a savings.

Table 4.2.
Mean energy intake for all observations of target individuals by socioeconomic standing (SES)

	Mean Energy Intake of Target Individuals			
SES	Adult Males	Adult Females	Schoolers	Toddlers
High	2,426.09±930.80 (n=588)	2,242.08±815.67 (n=664)	1,968.27±807.38 (n=340)	1,265.86±673.83 (n=374)
Upper Inter-mediate	2,124.31±823.36 (n=711)	2,050.43±659.19 (n=780)	1,622.49±505.22 (n=323)	1,046.67±458.47 (n=453)
Lower Inter-mediate	2,323.06±878.98 (n=2,055)	2,116.45±698.27 (n=2,181)	1,754.57±677.02 (n=804)	1,046.92±506.91 (n=1,099)
Low	2,357.12±941.41 (n=1,309)	2,139.24±831.48 (n=1,443)	1,747.57±675.25 (n=587)	1,054.69±566.43 (n=829)

Table 4.3.
Mean animal protein intake for all observations of target individuals by socioeconomic standing (SES)

	Mean Animal Protein Intake of Target Individuals			
SES	Adult Males	Adult Females	Schoolers	Toddlers
High	43.46±39.67 (n=588)	38.76±36.26 (n=664)	31.93±25.29 (n=340)	23.24±18.89 (n=374)
Upper Inter-mediate	36.29±34.36 (n=711)	32.84±31.31 (n=780)	24.70±22.72 (n=323)	18.68±16.37 (n=453)
Lower Inter-mediate	36.20±36.81 (n=2,055)	31.75±30.95 (n=2,181)	24.85±24.64 (n=804)	16.96±16.50 (n=1,097)
Low	35.62+37.41	30.24+32.53	25.17+25.03	16.31+16.44

Table 4.4.
Mean plant protein intake for all observations of target individuals by socioeconomic standing (SES)

SES	Mean Plant Protein Intake of Target Individuals			
	Adult Males	Adult Females	Schoolers	Toddlers
High	48.57±19.65 (n=588)	45.97±17.71 (n=664)	39.94±18.19 (n=340)	21.80±13.30 (n=374)
Upper Inter-mediate	44.53±19.21 (n=711)	43.88±16.52 (n=780)	34.05±11.21 (n=323)	18.64±9.56 (n=453)
Lower Inter-mediate	50.03±20.56 (n=2,055)	45.81±17.24 (n=2,181)	37.48±16.85 (n=804)	19.66±11.39 (n=1,099)
Low	52.12±21.24 (n=1,309)	47.50±18.23 (n=1,443)	38.46±15.43 (n=587)	20.38±12.50 (n=829)

Table 4.5
Mean animal fat intake for all observations of target individuals by socioeconomic standing (SES)

SES	Mean Animal Fat Intake of Target Individuals			
	Adult Males	Adult Females	Schoolers	Toddlers
High	44.88±35.29 (n=588)	38.76±36.26 (n=664)	32.01±24.78 (n=340)	24.86±21.83 (n=374)
Upper Inter-mediate	34.47±32.52 (n=711)	32.84±31.31 (n=780)	23.20±21.37 (n=323)	18.94±17.41 (n=453)
Lower Inter-mediate	33.41±34.12 (n=2,055)	31.75±30.95 (n=2,181)	23.06±23.09 (n=804)	16.05±15.94 (n=1,097)
Low	31.06±33.05 (n=1,309)	30.24±32.53 (n=1,443)	22.11±24.80 (n=587)	14.66±14.88 (n=829)

Table 4.6.
Mean plant lipid intake for all observations of target individuals by socioeconomic standing (SES)

SES	Mean Plant Lipid Intake of Target Individuals			
	Adult Males	Adult Females	Schoolers	Toddlers
High	27.20±23.67 (n=588)	26.26±22.16 (n=664)	22.61±17.05 (n=340)	15.12±12.45 (n=374)
Upper Inter-mediate	25.54±22.27 (n=711)	25.58±20.21 (n=780)	21.00±13.84 (n=323)	14.16±17.10 (n=453)
Lower Inter-mediate	30.10±22.62 (n=2,055)	28.40±21.54 (n=2,181)	23.16±16.42 (n=804)	14.78±12.43 (n=1,099)
Low	31.13±23.95 (n=1,309)	29.68±24.00 (n=1,443)	23.90±18.06 (n=587)	14.66±13.24 (n=829)

Table 4.7.
Mean carbohydrate intake for all observations of target individuals by socioeconomic standing (SES)

SES	Mean Carbohydrate Intake of Target Individuals			
	Adult Males	Adult Females	Schoolers	Toddlers
High	388.39±143.70 (n=588)	366.95±130.08 (n=664)	326.98±133.59 (n=340)	197.63±101.75 (n=374)
Upper Inter-mediate	354.85±134.22 (n=711)	344.39±112.58 (n=780)	275.36±84.29 (n=323)	168.56±71.05 (n=453)
Lower Inter-mediate	392.66±141.93 (n=2,055)	359.39±116.36 (n=2,181)	302.55±120.74 (n=804)	174.06±85.30 (n=1,099)
Low	403.45±148.41 (n=1,309)	370.60±130.66 (n=1,443)	300.74±112.54 (n=587)	179.76±97.11 (n=829)

Community socioeconomic data collected in January 1984 indicate that fully subsidized dietary staples, such as rice and oil, can be purchased with a food ration card for five piastres per kg. and ten piastres per kg., respectively. This compares to 30 piastres per kg. of rice and 30 piastres per kg. of oil at the local market. Beef, a very expensive commodity at the local market (4.25 Egyptian pounds per kg.) can be purchased frozen for one Egyptian pound per kg. at the food cooperative.

Although these services are available to all Kalamans, only those who really need them use them because a certain stigma is attached to accepting government issued food rations and shopping at the food co-op. In addition, meats available at the co-op are considered poor quality, other foods are seldom fresh, and crowds are intolerable to status-conscious Kalamans.

The use of government-subsidized food services is reflected in the mean energy, plant protein, plant lipid, and carbohydrate intakes of Kalamans when stratified by SES. These means also reflect the Kalama dietary pattern which emphasizes bread, legumes, rice, vegetables stewed with tomatoes and oil, and little meat due to its high price at the local market and poor quality (e.g. taste and texture) at the food co-op.

Individuals in the high SES group characteristically spend more money than individuals in any of the lower SES groups. This phenomenon is reflected in the data presented in Tables 4.2 to 4.7, suggesting their relatively high mean intakes of most food components. Those in the lowest two SES groups, surviving on extremely limited economic resources, often use their food ration cards or shop at the government food cooperative to afford an adequate diet which rarely departs from dietary staples. The fewer the family's economic resources, the more they rely on government subsidization, and the more subsidization they procure. This explains the inverse relationship between mean energy intake and SES suggested in the data on the lower three SES groups, i.e. in the low, lower intermediate and upper intermediate SES groups, mean kcals per day decrease as SES increases.

On the other hand, mean intakes for animal protein and animal fat stratified by SES suggest the occurrence of a very different phenomenon, one which characterizes the essence of social status and socioeconomic transition in Kalama.

As in most developing countries, meat consumption by the majority of families is limited to holidays or other special celebrations because of its expense. Since it is very costly, Kalamans consider it to be a high status or prestigious food item. In addition, since only poor quality meats and poultry are available at the food cooperative, less fortunate families opt to spend their money on additional dietary staples rather than on meat.

Therefore, level of animal protein and fat intake is based on the ability and desire to purchase fresh meats and poultry at a dear price in the local market. The data presented in Tables 4.3 and 4.5 suggest the support of this conclusion by indicating that mean animal protein and animal fat intake increase as SES increases.

The upper intermediate SES group presents an interesting case in their apparent relatively poor nutritional standing with respect to mean energy, carbohydrate, plant protein, and plant lipid intake as compared with the other three SES groups. This occurs in contrast to their second place standing (behind the high SES Group) in mean animal protein and animal fat consumption. We believe these data reflect the precarious socioeconomically transitional state of the upper intermediate SES group in Kalama. Ethnographic data support conclusions that these households often expend economic resources on high status foods and other non-dietary items for their home in lieu of expenditures on dietary staples. In addition, because acceptance of government food assistance is generally associated with lower SES groups, the status-conscious upper intermediate group rejects its offering of inexpensive dietary staple commodities. Hence, we observe a relatively high ranking in consumption of prestigious animal products and the lowest ranking for mean intakes of the major food components of the dietary staples.

In summary, data obtained on target individuals' mean daily intake of energy, animal protein and fat, plant protein and lipid and carbohydrate stratified by SES confirm the reality of the Egyptian government's policy of food subsidization in Kalama. Additionally, they also provide evidence for asserting the dynamic nature of socioeconomic transformation within Kalama's low, lower intermediate and upper intermediate SES groups.

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Descriptions of Selected Egyptian Foods

(Prepared by Dr. Nargis Bassily, the Nutrition Institute, Cairo)

Beverages

Toulu

Egyptian plant leaves. About 5 g of the leaves are soaked in about 100 ml of boiling water and then about 4 g sugar are added to this concoction. It is used for young and old people for calming nerves.

Sahlab

100 g dried milk + 50 g starch + 3 g cinnamon + 5 g chopped nuts and coconut + 10 g sugar. These ingredients are cooked in about 150 ml water with continuous stirring until somewhat semi-thick paste is obtained. Used in winter for energy.

Shih

Egyptian plant leaves named Santonine. About 5 g dried leaves are boiled in about 100 ml water.

Rehydran

To rehydrate the infant: Dissolve 0.9 g NaCl + 10 g glucose in 200 ml water. It is a physiological saline solution used in diarrhea and vomiting.

Cereal Grains and Cereal Grain Products

Fetir Meshalted

500 g wheat flour + 200 g butter and sufficient quantity of water to make a dough. Bake in the oven. It is usually eaten while it is hot with honey or cheese.

Besisa

About 1/2 kilo maize flour + 4 eggs + one cup fresh milk + one cup butter fat + 200 g sugar. All the ingredients are mixed together and baked in hot oven.

Basbousa

About 1/2 kilo simolina flour (type of wheat four, imported) + 1/2 kilo sugar + 250 g yogurt + 50 g butter fat. All the ingredients are mixed and baked in hot oven.

Fetir

500 g wheat flour + 50 g butter fat + 200 g milk + 150 g sugar. All the ingredients are mixed and baked in hot oven.

Lokmadis

250 g wheat flour + 20 g dried yeast are mixed with an amount of water sufficient to make a paste. It was left until it ferments. Small pieces are fried in very hot oil. The fried pieces are dipped while hot in a concentrated sugar solution.

Mafrouka

Wheat flour and water rolled in hands to small pieces. Place in steamer to cook. Eat with hot butter (1 Tablespoon) and sugar (1 Tablespoon) or milk (200 ml) and sugar (1 Tablespoon).

Tehina

Residue of semame seed after extraction of oil

Sadel hanak

Little water added to about 20 g wheat + 20 g sugar. Mix and fry in hot oil.

Fats and Oils

Morta

After evaporating water from butter or cream, it is converted into samna or ghee. Morta is the residue which is composed mostly of protein and minerals.

Fish and Seafood

Karameet

It is a kind of fish which is black in color.

Fruits and Fruit Juice

Dome

Dried fruit of Egyptian trees grown only in upper Egypt. It contains sweet fibers.

Kharoub

Sweet dried fruit of Egyptian trees.

Legumes and Legume Products

Hab el aziz

Small dried seeds which are usually soaked in fresh water for 24 hours before eaten. It has a sweet taste.

Meat, Poultry and Meat Products

Basturma

Preserved dried beef meat. Fresh meat is salted, fluids are extracted from meat by putting heavy weights over the meat. After all the juice is out, the meat is covered by a thick paste made of the following ingredients:

1. Dried powdered fenengreer
2. Garlic
3. Red pepper

After the meat is covered by the previous mentioned ingredients it is left in a current of air until it becomes dry.

Semman

It is a kind of bird called Kay. It comes from Europe to Egypt only in winter.

Yamam

A native small bird half the size of the pigeon.

Seasonings and Condiments

Habhan

Yellowish green seeds named cardamon. It is used as flavoring agent in chicken soups.

Chinese Kabeba

It is a very hot kind of spice.

Dokka

It is a mixture of the following ingredients:

1. Ground toasted sesame seeds
2. Ground (powder) cummin
3. Powder sodium chloride

Sugars, Sweets, Cakes and Candies

Kataif

A type of semi baked bread stuffed with dried grapes, chopped nuts and coconut. This is fried in hot oil. It is then soaked in concentrated sugary liquid.

Konafa

About 500 g wheat flour mixed well with sufficient amount of water to obtain an emulsion. This emulsion is put in a porous cup and the emulsion is dropped on a hot plate. It is baked in short time on the hot plate and threads of Konafa are obtained. This material is mixed with about 40 g butter. It is put in a hot oven until its color becomes nearly light red. A concentrated sugary solution is poured on it while it is hot.

Mishabek

About 50 g wheat flour mixed well with sufficient amount of water to obtain an emulsion. The emulsion is put in a porous cup, the pores are somewhat large. The emulsion which falls from the pores is fried in hot oil. The fried pieces are dipped in a concentrated sugary solution.

II. ANTHROPOMETRY

A. Introduction

Accurate documentation of body size and composition was critical to several aspects of the CRSP design. Anthropometric protocols were designed to emphasize quality control, since the rates of change expected in many of the variables were small compared to the inherent error of measurement due to equipment, observer, and subject.

The schedule of data collection for anthropometry is shown in Table 4.8. This schedule was supplemented by body weights taken for adults and some schoolers at the time of RMR measurements and by occasional extra weight measures during illnesses.

Table 4.8.
Schedule of anthropometric measurements

Measure	Subjects					
	Male	Female*	Lead Infant	Lead Toddler	Schooler	All Others in HH
Weight	Once/ Month	Once/ Month	Once/ Month†	Once/ Month†	Once/ Month	2x/year
Height or Length	once	once when not pregnant	monthly	monthly	every 3 mo	once
Arm Circum-ference		every 3 mo	every 3 mo	monthly	monthly	every 3 mo
Head Circum-ference				monthly	monthly	1st and 12th month
Skinfolds		every 3 mo	every 3 mo	monthly	monthly 3 mo	every 3 mo

*Weight, height, arm circumference, and skinfold measurements were taken on pregnant women monthly.
†Extra weights were planned during illness but not done.

The scheduling of body weights every month on all targets proved to be unrealistic in terms of staff and scales available. Every effort was made to adhere to the schedule, but missing data are substantial in some subsets.

Measurements were taken as close as possible to the scheduled date. Most subjects were measured in their homes, although some data on school children were collected during visits to the school; weights collected at the time of RMR measures were taken in the clinic environment. Young physicians did all measures except those for target infants, which were accomplished by the reproduction field team.

B. Measurements

For nontarget individuals, height and weight were measured to enable calculation of variables related to the household. For targets, measurements selected were the minimal ones necessary to ascertain change in body size and energy reserves: height (length for infants and toddlers), body weight, midarm circumference, skinfoids at two sites (triceps and biceps) and for children, head circumference.

Phase I experience made it clear that the selection of skinfold sites for ongoing data collection would be limited by cultural constraints. The original interproject agreement to collect data on subscapular skinfolds had to be modified because most adults and many schoolers refused this measurement except in the context of a physical examination. Thus the skinfold sites were limited to triceps and biceps except for infants and toddlers.

C. Equipment

For routine home visits, Heathkit Model #GD-1186 electronic scales were used. These scales are claimed by the manufacturer to be accurate to plus or minus three percent. Each time the scales were moved, they were re-zeroed; calibration with 5, 10, and 25-kg standard weights was accomplished at least once each day (after movement of the scales to the field) but was not possible between each move from house to house. Batteries were replaced every two weeks before they began to be drained. Each team of physicians was assigned a particular scale for which they had the responsibility of ongoing care and maintenance. The Heathkit scales were not yet available in the first two months of Phase II; during that time, an Accuweigh "portable" bench beam balance was used in the field. When the Heathkit scales arrived, the bench beam balance was installed in the clinic for use at the time of RMR measurements.

For target infants, a K-Tron Electronic scale was used for weighing. This battery-operated balance is extremely sensitive (to 10 grams) and operates well in the field because it does not depend on being level. It averages several measurements over 3 seconds thus stabilizing the readings from a moving infant; and the digital display can be accurately read in poor light.

Length measurements on infants and toddlers were made using a portable wooden length/stature board. For older children and adults, height was measured using a stadiometer-type arrangement made against a vertical wall. Arm and head circumference measures were made using Zerfas paper insertion tapes, and skinfold measures were taken with Lange calipers. The skinfold calipers were checked against standard calibration blocks regularly.

D. Standardized Methods for Measurement

1. Weight

All except infants stood on the scale with weight equally distributed over both feet. Sometimes toddlers sat on the scale instead. All scales were zeroed before each weighing. The Heathkit and beam scales were read to the nearest 0.1 kg; the K-Tron to the nearest gram. Infants were placed on the scale in a supine position.

Consistent attempts were made to minimize the amount of clothing worn by subjects during weighing, to the "next layer after underwear" specified in the field manual. This was not always possible because of local standards of modesty and, in winter, the environmental temperature. The most difficult of these problems involved the heavy outer garment worn by women outside their homes. This black overdress is worn over other clothing, and when women appeared for the RMR measurements at the clinic they usually were so dressed. When the women were weighed in their own homes this garment was not worn. Accordingly, an average weight for this garment was subtracted from weights taken during the RMR protocol. For infants, for whom accurate weight measurements were essential and weighing naked or even with minimal clothing was unacceptable to families, the following procedure was used: the infant was weighed clothed; the clothing was gradually removed and replaced with other garments so that the infant was never undressed completely; the original clothing was weighed carefully and subtracted from the clothed weight. The accuracy of the K-Tron

balance made this procedure possible. In cases where more clothing was worn than the field manual specified, an adjustment was made in the field before data recording, based on the weight of the subject's or similar garments.

2. Height/Length

Length was measured, rather than height, to age 30 months in order not to change methods midway through the toddlers' study. Using a horizontal measuring board, the child was placed supine on the board with his feet flat against the perpendicular bottom of the board. The child's head was held in the Frankfort plane perpendicular to the board with the legs and spine straight while the moving headboard was placed against the top of the head. The board was read to the nearest 0.1 cm. Older subjects stood with their backs against a stadiometer, heels together and touching the backboard surface. The head was held in the Frankfort horizontal plane. With the scapulae and/or buttocks against the backboard surface, the headboard was placed firmly against the top of the head and read to the nearest 0.1 cm while the person inhaled deeply.

3. Midarm Circumference

The subject's left arm was held at a 90° angle at the elbow with the palm of the hand upward. The midpoint of the posterior portion of the arm was determined by calculating halfway between the posterior part of the acromion process of the scapula and the olecranon process of the elbow. The measuring tape was placed over the midpoint with the tape parallel to the floor while the arm hung relaxed at the side. Light tension was applied to the tape in order to have contact with all sides of the arm and the tape was read to the nearest 0.1 cm.

4. Head Circumference

The subject sat upright with the head held level, except infants who were lying down with the head turned to one side where the largest circumference was visible. The tape was placed above the eyebrows with the lower border of the tape touching the brow and moved along the back of the head to locate the largest portion. Firm pressure was applied to the tape to fit snugly around the head and the tape was read to the nearest 0.1 cm.

5. Skinfold Thickness

The left side was used for all measurements. For each site the skin was grasped 1-2 cm above the site to separate the fat from the underlying muscle, and the reading (to the nearest 0.5 mm) occurred three seconds after applying the caliper. Each measurement site was located by standardized procedures. For the triceps, the arm hung at the side with the palm toward the body and the measurement was taken at the same level marked for the midarm circumference. For the biceps, the fold was taken at the same level, in the midline of the arm on a plane directly posterior to the maximum bulge of the biceps. The subscapular site, when measured, was taken directly under the inferior angle of the scapula on the left side, on the angle of the scapular edge.

E. Quality Control

Quality control measures for anthropometry assumed great importance in training and fieldwork because of the longitudinal nature of the study and the necessity for multiple observers. These measures included staff training, duplicate measurements on a large subset of all measures, maintenance of equipment, and ongoing monitoring of reliability.

1. Staff Training

A core field manual was prepared for staff training in order to standardize methods across all field workers. The primary initial trainers (Egyptian and US) first standardized their methods against each other and then devised training protocols. Dr. Farouk Shaheen functioned as "expert in residence" and was responsible for training and ongoing quality control in anthropometry. For approximately one month, young physicians underwent training in morbidity and anthropometry. The anthropometry training included lectures and demonstrations about equipment and measurement protocols, prac-

tice on each other and on subjects of all ages, calculation of measurement error, and discussion of the reasons for quality control protocols. As new physicians joined the staff, their training included standardization against more experienced observers with one experienced senior scientist serving as the "gold standard." At intervals throughout the fieldwork, staff meetings were devoted to issues in anthropometry including quality control.

2. Reliability Measures

Permissible inter-observer error limits were adopted from those used by the Fels Longitudinal Growth Study in Yellow Springs, Ohio. The recording form was designed to be folded so that a second observer could record measurements without seeing the data of the first observer; the form could then be unfolded to compare the measures, and if the difference exceeded the preset limit (printed on the form) the measure was retaken. About 50% of all anthropometric measurements had duplicate observations. In addition, a third party "expert" (usually Dr. Shaheen) repeated measurements at irregular intervals as a further quality control check.

Forms were routinely checked for reliability where there were duplicate measurements, and retraining occurred whenever problems were suspected. Coefficients of variation and technical error of measurement were calculated on subsamples of the data to ensure that quality control was maintained. This ongoing monitoring disclosed a reluctance of data collectors to record disparate data. Ongoing observation proved that the field protocol that was most comfortable for the Egyptian data collectors--i.e., to investigate any discrepancies and resolve them on the spot--did not compromise accuracy and may have enhanced it.

3. Maintenance of Equipment

Calipers and tapes were included in each "doctor's bag" along with standard physical examination equipment (otoscope, sphygomanometer, etc.), and each bag was assigned to a pair of physicians. Calipers were checked against a standard measuring block at regular intervals. Scales and measuring boards were the responsibility of the young doctor assigned as field coordinator; batteries were changed at regular intervals and any problems were dealt with on the spot if possible.

4. Data Cleaning

After anthropometric data were entered, range checks were applied. Out-of-range values were checked and corrected if in error. Further checks involved longitudinal plots of values of individuals to detect measurements obviously in error but not outside the range checks. By far, the majority of errors in the data proved to be keypunch errors, ID errors, or simple transpositions of numbers which could be resolved by checking against the original forms. Questionable values that could not be resolved were deleted.

F. Components of Variance in Anthropometric Data

Anthropometric data were analyzed to determine the precision (technical error of measurement) and dependability (stability over short periods of time) of each measurment. This terminology ("precision" and "dependability") is consistent with that used by others (Habicht, et al., 1979; Mueller and Martorell, in press) and allows the reader to interpret the utility of the data set for use in time-dependent analytical models. In other words, if one is to look for change in an anthropometric measure over a one-month or a three-month period, it is useful to know how stable that measure is over a period less than that time, as well as to know the precision of the measure under the circumstances of data collection.

Analysis was done on a partial data set which represented all anthropometric data collected after July 1984. Thus, the first months of data collection (November 1983 through June 1984) were not included. The reason for this omission was strictly practical, since the earlier data had been keypunched in Kansas and the version available to the Arizona investigators at the time of analysis had averaged values for duplicate observers. The data collected after July 1984 had been keypunched in Egypt, and the Arizona investigators had that data set available since we had completed the data clean-

ing on that data base; duplicate observations had been preserved in the data set. There is no reason to think that this portion of the anthropometry data set, which comprised more than half of the measurements taken, was not representative of the whole set.

All cases were selected which met the following criteria: a duplicate observation on the same day, AND a second measurement within a time frame which was arbitrarily chosen to represent a time within which we would not expect functionally significant change to occur (i.e., growth, or significant change in body composition). These time windows varied by measurement and type of target individual (see Table 4.9). Pregnant women were omitted, since the stage of pregnancy could not be known from the anthropometry data alone. Individuals who met the criterion more than once (i.e., who two or more sets of data on the same measurement which met the criterion above) were used only once for that measurement, the first time such an occurrence appeared in the data set.

TABLE 4.9.
Time frames for selection of repeat measures

Measurement	Target Type	Time 'Window'
Height	Adults	Any two measurements not on the same day
	Schoolers	Within three months
Length	Toddlers	Within two months
	Infants	Within two weeks
Weight	Adults	Within two months
	Schoolers	Within one month
	Toddlers & Infants	Within two weeks
Head circumference	Schoolers & Adults	Any two measurements not on the same day
	Toddlers	Within one month
	Infants	Within two weeks
Arm circumference	Adults & Schoolers	Within three months
	Toddlers & Infants	Within two months
Skinfolds	Adults & Schoolers	Within three months
	Toddlers & Infants	Within one month

From the potential set of measures, head circumference on adults and infants, length on infants, and subscapular skinfolds on all targets were eliminated on the basis of too few cases which met the stated criteria. For the other samples of measures, distributions were compared to those of the total data set for that measure on that type of target to assure representativeness of the data set to be analyzed. There were no significant differences.

The next step was to evaluate whether there were scale effects present in same-day or different-day data sets; i.e., whether the absolute value of the measurement contributed to imprecision or undependability. This was done according to the method recommended by Mueller and Martorell (in press), namely to regress (a-b)/2 on (a+b)/2, where a and b are the two measurements. None of the regressions were significant; i.e., within the ranges of measures in the data set, no signifcant scale effects on error could be detected. Thus, none of the distributions were transformed before further analysis.

The data were then subjected to two-way repeated measures analysis of variance using the Reliability procedure in SPSSX. Two distinct analyses were performed: the computation of precision followed by the computation of dependability, which requires knowledge of precision.

In the first analysis, the variance components of imprecision were obtained using duplicate observations on the same day as dependent variables. This was done according to the method recommended by Mueller and Martorell where the difference squared between the two observations on the ith subject, summed over N observation days, is equal to the component of imprecision.

In the second analysis, the variance components of undependability were obtained with dependent variables, being defined as the first replicate observation on each day for two observations falling within the developmental time frame. Standard estimates of inter-individual and intra-individual variance components were then obtained. Based upon Mueller and Martorell's formulas, variance due to imprecision was subtracted from the intra-individual variance in order to obtain an estimate of dependability. Estimates of reliabilty as a coefficient from 0 to 1 for precision and dependability were defined as the ratio of that component's variance to the overall inter-individual variance minus one. The overall reliability for the sample was defined as the ratio of intra-individual variance to inter- individual variance minus one.

Tables 4.10-4.13 give the results of this analysis.

Table 4.10 presents all the relevant variance components and corresponding reliability, precision, and dependability for each measurement on each target type. For ease of interpretation, we may regard the value of R as the percentage of the variance which is free of intra-individual factors including measurement error. P and D, respectively, represent the proportion of the variance which may be regarded as free from inter-observer error (imprecision of the measurement) and undependability (short-term variation in the measure). Unlike other studies which have looked at shorter periods for determining undependability (usually hours or at most a few days), most of the intra-individual variation in our data set is from the undependability component.

Table 4.11. Summarizes the coefficients of variation for the inter-individual and the two intra-individual components of variance.

Table 4.10. Components of unreliability (r^2), imprecision (p^2), and undependability (d^2) of anthropometric measurement variances (s^2) and their corresponding reliabilities (R), precisions (P), and dependabilities (D) in CRSP target subjects

		Standard Deviations			Variance Components						
Measurement*	(n)	r	p	d	r^2	p^2	d^2	s^2	R	P	D
Lead Males											
Weight (kg)	(56)	3.23	0.06	3.231	10.443	0.004	10.439	300.840	0.97	1.00	0.97
Height (cm)	(37)	2.09	0.15	2.081	4.353	0.023	4.33	79.190	0.95	1.00	0.95
Arm Circumference (cm)	(78)	1.04	0.09	1.038	1.085	0.008	1.077	22.951	0.95	1.00	0.55
Biceps Skinfold (mm)	(79)	1.89	0.29	1.872	3.587	0.084	3.503	24.511	0.85	1.00	0.86
Triceps Skinfold (mm)	(79)	5.62	0.37	5.607	31.571	0.137	31.434	101.605	0.69	1.00	0.69
Lead Females (Lactating)											
Weight (kg)	(195)	3.27	0.52	3.230	10.703	0.270	10.433	263.065	0.96	1.00	0.96
Height (cm)	(121)	4.80	0.34	4.788	23.038	0.116	22.922	65.709	0.65	1.00	0.65
Arm Circumference (cm)	(240)	1.54	0.25	1.520	2.374	0.063	2.311	23.064	0.90	1.00	0.90
Biceps Skinfold (mm)	(191)	4.19	0.90	4.091	17.547	0.810	16.737	63.069	0.72	0.99	0.73
Triceps Skinfold (mm)	(194)	5.46	1.06	5.352	29.764	1.124	28.640	131.409	0.77	0.99	0.78
Schoolers											
Weight (kg)	(60)	1.23	0.05	1.224	1.501	0.003	1.499	24.134	0.94	1.00	0.94
Height (cm)	(85)	5.87	0.11	5.872	34.490	0.012	34.478	88.137	0.61	1.00	0.61
Arm Circumference (cm)	(89)	0.89	0.05	0.893	0.800	0.003	0.798	2.734	0.71	1.00	0.71
Biceps Skinfold (mm)	(88)	1.72	0.22	1.706	2.957	0.048	2.909	4.124	0.28	0.99	0.29
Triceps Skinfold (mm)	(88)	1.99	0.23	1.975	3.955	0.053	3.902	10.057	0.61	0.99	0.61
Head Circumference (cm)	(37)	1.71	0.10	1.711	2.938	0.010	2.928	9.593	0.69	1.00	0.69
Toddlers											
Weight (kg)	(26)	1.34	0.04	1.337	1.790	0.002	1.788	5.803	0.69	1.00	0.69
Length (cm)	(139)	2.06	0.53	1.992	4.250	0.281	3.969	35.751	0.88	0.99	0.89
Arm Circumference (cm)	(137)	0.99	0.09	0.984	0.977	0.008	0.969	3.230	0.70	1.00	0.70
Biceps Skinfold (mm)	(125)	1.95	0.44	1.896	3.790	0.194	3.596	5.828	0.35	0.97	0.38
Triceps Skinfold (mm)	(125)	2.16	0.47	2.108	4.666	0.221	4.445	10.490	0.56	0.98	0.58
Head Circumference (cm)	(96)	1.30	0.08	1.293	1.679	0.006	1.673	5.804	0.71	1.00	0.71
Infants											
Weight (g)	(44)	21.65	0.73	21.639	468.767	0.533	468.234	45843.078	0.99	1.00	0.99
Arm Circumference (cm)	(65)	1.13	0.02	1.126	1.269	0.000	1.269	3.495	0.64	1.00	0.64
Biceps Skinfold (mm)	(47)	1.51	0.35	1.467	2.274	0.123	2.151	4.837	0.53	0.97	0.56
Triceps Skinfold (mm)	(47)	2.00	0.41	1.953	3.984	0.168	3.816	7.918	0.50	0.98	0.52

TABLE 4.11.
Coefficients of variation of anthropometric data

Target Type	Measurement	(n)	Inter Individual	Between Measurement	Between Observers
Lead Males	Weight (kg)	(56)	25.34	4.72	0.09
	Height (cm)	(37)	5.31	1.24	0.09
	Arm Circumference (cm)	(78)	17.67	3.83	0.33
	Biceps Skinfold (mm)	(79)	80.02	30.26	4.69
	Triceps Skinfold (mm)	(79)	83.23	46.30	3.06
Lead Females (non-pregnant)	Weight (kg)	(195)	25.34	5.00	0.80
	Height (cm)	(121)	5.22	3.08	0.22
	Arm Circumference (cm)	(240)	17.98	5.69	0.94
	Biceps Skinfold (mm)	(191)	54.90	37.40	8.23
	Triceps Skinfold (mm)	(194)	53.90	25.16	4.98
Schoolers	Weight (kg)	(60)	21.35	5.32	0.22
	Height (cm)	(85)	7.86	4.91	0.09
	Arm Circumference (cm)	(89)	10.34	5.58	0.31
	Biceps Skinfold (mm)	(88)	42.95	36.08	4.65
	Triceps Skinfold (mm)	(88)	37.40	23.29	2.71
	Head Circumference (cm)	(37)	6.15	3.40	0.20
Toddlers	Weight (kg)	(26)	22.16	12.30	0.37
	Height (cm)	(139)	46.08	2.57	0.68
	Arm Circumference (cm)	(137)	13.32	7.29	0.67
	Biceps Skinfold (mm)	(125)	38.97	30.61	7.10
	Triceps Skinfold (mm)	(125)	32.87	21.40	4.77
	Head Circumference (cm)	(96)	5.18	2.78	2.15
Infants	Weight (g)	(44)	38.77	3.92	0.13
	Arm Circumference (cm)	(65)	17.13	10.32	0.18
	Biceps Skinfold (mm)	(47)	42.49	28.35	6.76
	Triceps Skinfold (mm)	(47)	37.15	25.78	5.41

Table 4.12 compares reliability (R) and imprecision standard deviation (usually referred to as Technical Error of Measurement) of the CRSP data set with published data sets available from the literature. Values for adults are compared to the NHANES-II data, and those for toddlers to the preschool data set reported by Martorell, et al. (1975). Both sets are taken from the paper by Mueller and Martorell (in press). Note that technical error of measurement (p) is very similar to that in the comparison data sets for most measures. The error for length in the CRSP data is slightly greater than in the other set. For skinfolds on adults, the technical error is less in the CRSP data set than in the NHANES, especially for men. This may reflect a generally thinner population with less inherent error in the measurement. Overall reliability, however, is lower in the CRSP data set in general. This is especially the case for measures on toddlers. Undependability of the measure, as we have defined it, accounts for the difference and is very likely a function of the longer "windows" of time within which we have analyzed repeated measures (weeks rather than hours or days).

TABLE 4.12.
Reliability and technical error of measurement of CRSP data compared to those of published data sets similarly analyzed

Individual	Reliability (R)		Technical Error of Measurement (p)	
	NHANES -II	CRSP	NHANES -II (N=59-62)	CRSP (N=37-139)
Men				
Body Weight (kg)	1.00	0.97	0.04	0.06
Stature (cm)	0.99	0.95	0.24	0.15
Arm Circumference (cm)	0.99	0.95	0.33	0.09
Triceps skinfold (mm)	0.86	0.69	2.41	0.37
Women				
Body weight (kg)	1.00	0.96	0.03	0.52
Stature (cm)	0.99	0.65	0.32	0.34
Arm Circumference (cm)	0.99	0.90	0.40	0.25
Triceps skinfold (mm)	0.91	0.77	3.24	1.06
	Martorell et al., 1975	CRSP	Martorell et al., 1975	CRSP
Toddlers				
Weight (kg)	0.94	0.69	[illegible]	0.04
Length (cm)	0.99	0.88	0.34	0.53
Arm Circumference (cm)	0.94	0.70	0.57	0.09
Head Circumference (cm)	0.94	0.71	0.14	0.08
Triceps skinfold (mm)	0.93	0.56	0.47	0.47

To check this assumption, we compared the data so analyzed from the CRSP data set with a small substudy on toddler weights we did early in Phase II in order to estimate day-by-day variation. In the latter study, 14 toddlers were measured by the same pair of observers three times, with measurements every other day. Table 4.13 shows that the inter-observer variance (within- measurement) was comparable in the two data sets. The between-measurement variance, however, was much larger with the two week window. While only about 3 percent of the observed variance was due to variation over a two day period, about 30 percent can be accounted for intra-individual variation within a two week period.

TABLE 4.13.
Comparison of variance and coefficient of variation of toddler weight taken within 2 days versus within 2 weeks

	Within 2 weeks, 2 measures (N = 78 measures on 26 individuals)	Every other day, 3 measures (N = 78 measures on 14 individuals)
Within-Measurement (Between observers, same Day)		
Variance	.092	.0027
CEV	0.5[illegible]%	0.46%
Within-person, Between measurements		
Variance	1.788[a]	.0479[a]
CEV	12.30%	1.94%
Between-Person		
Variance	5.803[c]	1.9328[c]
CEV	22.16%	12.29%
Ratio of: a/c	.31	.03

In conclusion, the precision of measurement in the CRSP anthropometry data set is comparable to that in other well-controlled, published large studies. Intra-individual variation over periods of time shorter than the functional relationships we are investigating account for larger shares of the variance, ranging from 3 percent for body weight in adult males to more than 50 percent for skinfold measurements in children. Undependability is relatively low for body weight except in toddlers, where it is significant and should be taken into consideration in the construction of time-dependent analytical models.

G. References

1. Martorell R, et al. The identification and evaluation of measurement variability in the anthropometry of preschool children. Am J Phys Anthrop 1975;43:347-62.

2. Mueller WH, Martorell R. How to measure measurement error. In Lohman T, Roche G, Martorell R. Anthropometric Standardization Manual. Human Kinetics Publishers, in Press.

III. MORBIDITY

A. Introduction

The CRSP design called for documentation of the health status of all members of target households and for ongoing monitoring of illness experience during the course of the study. For target individuals, documentation of illness experience over the course of the year was to be continual and to include sufficient information to characterize each illness by duration, severity, and diagnosis. Such detail was necessary in order to be able to relate food intake to morbidity in a fashion that would allow the study of temporal relationships. For nontarget individuals in study households, sufficient information on illness experience was required to establish household-level morbidity variables.

These data were collected by a cadre of "young physicians," medical graduates who had completed their internships and were serving their two-year social service commitment prior to specialty training. The original group of 13 physicians who participated in the Phase I fieldwork was augmented, as time went on, by colleagues who joined the NI at approximately six-month intervals. Training was therefore a continuous process as new doctors joined the group and those with more experience moved into positions of leadership within the CRSP or other activities, or left to continue their training. In all, more than 60 young physicians worked in the CRSP.

The organization of data collection called for coordination with existing health care facilities in Kalama and for a systematic approach to the provision of health care for target families. Kalama is served by a government health clinic staffed by two physicians and several other personnel; in addition, village residents make frequent use of other sources of medical care including private physicians in nearby cities.

Since the CRSP project was to provide physical examinations at regular intervals and close supervision of illnesses for participating families, it was decided that the project's young doctors would provide medical care for these families for primary care problems, referring complicated cases to appropriate facilities. The freedom of the participating families to utilize the village clinic and other providers was not restricted, and some continued to use multiple sources of medical care. We took special care to involve the three traditional midwife-practitioners in Kalama in the project, particularly with regard to identification of pregnancies and following of target pregnant women and infants.

The project medical staff agreed upon standardized treatment protocols for commonly-encountered conditions and made the necessary care available free of charge to the families. Standardized treatment protocols may be found in the morbidity field manual. The CRSP project did not intend to provide medical care for other households in the village, but the frequent requests from relatives and neighbors of participating households were met whenever possible. Special care was taken to support and maintain communication with the health center's doctors and other staff.

B. Types of Data Collected

1. Medical History and Physical Examination

Upon entry to the study all household members (targets and nontargets) underwent a medical history interview and general physical examination in their homes. The medical history included information on disabilities and chronic illnesses, childhood communicable diseases and immunization status, as well as a past-six-months history of common illnesses including diarrhea, respiratory and urinary tract infections. For married women, a reproductive history was also taken in detail. The physical examination included a general examination of all systems, with particular attention to identification of signs and symptoms of nutritional deficiency.

The data collection forms and procedures were developed following Phase I pilot testing. In Phase I, 63 families were given physical examination and medical histories, and these data were summarized to provide a general picture of the health status of typical families in the village. The Phase I experience identified: features that were refused by most subjects (e.g., genital examinations in adults); understandability of the questions asked; conditions that were too infrequent to call for separate items on the form; and ease of administration of the examination and history draft forms. The

Phase I experience also made it clear that it would be advantageous for the physicians to work in teams of two whenever possible, to provide for help in recording data and to provide, where possible, a male and female physician to accommodate the preferences of individual family members for examination. It was not always possible to adhere to this plan throughout Phase II, but when possible, field teams were organized along these principles.

Target individuals had the medical history and physical examination repeated at approximately six month intervals, i.e., at entrance, midway through the study, and at exit. Nontargets had these data collected only at study entry. Considerable effort was expended to complete the data base for all household members. If an individual was absent or otherwise unavailable on the date on which other household members were examined, the doctor returned at a more convenient time.

2. Morbidity Recall

In Phase I, a draft morbidity recall form and protocol were tested on a sample of 20 households for four weeks. In addition, Phase I activities included a focused, ethnographic investigation directed toward the perceptions and reporting of mothers about children with diarrhea, since several terms exist for diarrhea in Egyptian colloquial and formal Arabic, and the definition of the condition was expected to vary with local norms. The resulting information was used to decide which aspects of diarrhea (number of stools, color, other characteristics) were noted by mothers of young children and could be accurately reported. Mothers' perceptions of when diarrhea was severe and types of treatment sought were also explored and resulted in incorporation of data in the Phase II form on treatment of diarrheal illnesses (both traditional home-based and medical). The initial phases of the CRSP took place before the nationwide campaign to promote oral rehydration therapy for diarrhea in children; this program developed in earnest in 1984 and 1985.

The basic design for documenting illness experience in Phase II was a weekly recall, in which the subject reported for him/herself, or another competent family member reported for the subject (usually the mother for a young child). Teams of two doctors were assigned a group of households and arranged their schedules so that one of them visited the household every seven days. At least once a month they visited together, or with another physician on the team, so that monthly anthropometry could be performed with two observers. On the day of the visit, the doctor asked the respondent(s) whether each person in the household had been ill in the previous seven days (since the last visit). Specifically, inquiries were made about several categories of illness (gastrointestinal, respiratory, ear, eye, skin, joint/extremity, fever, urinary tract). In addition, schedules were included for limitation of activity (to be filled out for any illness in which normal activities were limited) and for pregnancy. The pregnancy form was filled out each week for pregnant women and noted such items as fundal height (if an exam was made), quickening, fatigue, nausea, any complications, and their treatment.

For nontarget individuals, the data base consists of "yes" or "no" responses for each of the above categories on a weekly basis. For target individuals, a "yes" response in any illness category prompted a detailed history of the illness, and if the individual was present, a brief physical examination. Date of onset, date of resolution (if the illness had resolved), signs and symptoms were recorded on a precoded schedule. Particular signs and symptoms were selected with a view to establishing accurate diagnoses and to constructing indices of severity. If the illness was ongoing on the date of the recall interview, the following recall established the ending date of the illness. A new episode of the same illness was defined as one that occurred after at least two symptom-free days.

Illnesses identified in target individuals were assigned diagnostic codes as listed in the morbidity field manual. Codes were agreed upon in inter-project meetings with the Kenyan and Mexican investigators. The examining physician recorded the "most likely diagnosis for this illness" on the form. At a later time, an independent physician reviewed the form and indicated a most likely diagnosis based on the signs and symptoms recorded. In the case of disagreement, the form was referred to the senior scientist in the morbidity area for resolution. A "final diagnosis" for the illness was then recorded, and this code forms the identifying data for the illness in the data base. A "map" for conversion of project diagnostic codes to 1980 ICDA codes has been archived with ME.

It is important to note that both signs and symptoms AND diagnostic codes are contained in the data base. When an illness involved symptoms or signs in more than one organ system, more than one schedule would be filled out. If there

was a clinically unifying diagnosis, it would appear on the several schedules. Two examples will illustrate the structure of the data. In the case of measles, schedules would have been filled out for skin, eye (if conjunctivitis was present), fever (if present), and respiratory symptoms; the diagnostic code for measles would appear on all schedules. In the case of diarrhea with dehydration and fever, the diagnostic codes for diarrhea and dehydration would appear on Schedule A (gastrointestinal); in addition, the code for "fever with other symptoms" would appear on Schedule G (fever). In the case of an ailment with low frequency for which a diagnostic code did not appear in our list, the ailment would occur in the data base in the form of symptoms only, i.e., shoulder pain would be coded as a "joint/extremity problem, other" with the details on the schedule indicating pain in the shoulder but no attempt to discern arthritis, bursitis, or other possible diagnoses.

Severity criteria were applied in the data analysis phase. The following list describes criteria for severe illness; if none of these criteria was present, the illness was categorized as mild.

Attachment/diagnosis	Diagnosis is severe if recall indicates any of the following symptoms (1=yes)	Variable name for symptoms in Recall attachment
A: Gastrointestinal/		
Diarrhea (07:02 diagnostic code, DX2 variable name)	3 stools in last 6 hrs = 1 OR	DIAR13
	4 stools in last 6 hrs = 1 OR	DIAR14
	5-7 stools in last 6 hrs = 1 OR	DIAR15
	8 or more stools in last 6 hrs = 1 OR	DIAR16
	convulsions = 1 OR	DIAR20
	vomiting = 1 OR	VOMIT1
	frequency of urination decreased = 1 OR	DEHYD2
	tears: small = 1 OR	DEHYD4
	tears: none = 1 OR	DEHYD5
	mouth: sticky or dry = 1 OR	DEHYD7
	fontanelle: fallen = 1 OR	DEHYD9
	skin: loose/tenting = 1 OR	DEHYD11
	eyes: glazed/sunken = 1 OR	DEHYD13
	vomiting (07:01 diagnostic code) = 1 OR	DX1
	jaundice (07:07 diagnostic code) = 1 OR	DX3
	dehydration (07:05 diagnostic code) = 1	DX4
B: Respiratory/		
Common cold (05:01 diagnostic code, DX5 variable name)	temp. greater than 39.0° C axillary or age of child under 1 year	TEMP individual ID# = 5 --
Any respiratory diagnosis with the symptom Sore throat (throat: red injected, RESP32 variable name)	temp. greater than 39.0° C axillary	TEMP
Tonsillo-pharyngitis (05:03 diagnostic code, DX2 variable name)	temp. greater than 39.0° C axillary or tonsil size = 3 or 4	TEMP RESP34
	throat: exudate = 1	RESP35

Bronchitis (05:05 diagnostic code, DX7 variable name)	Diagnosed condition is always classified severe	
Pneumonia (05:07 diagnostic code, DX4 variable name)	Diagnosed condition is always classified severe	
Croup (05:04 diagnostic code, DX3 variable name)	cyanosis = 1 or elevated respiratory rate for age (see attachment) OR respiratory distress = 1 OR retractions = 1	RESP5 RATE RESP18 RESP20
Whoop or paroxysms with or without vomiting	This symptom identifies pertussis, a condition which is always classified severe	RESP11
C: Ear/		
Mastoiditis (03:03 diagnostic code, DX4 variable name)	Diagnosed condition is always classified severe	
Otitis media (03:02 diagnostic code, DX1 variable name)	drainage: purulent = 1 OR temp. greater than 39.0° C axillary	EAR15 or EAR16 TEMP
Foreign body/trauma (03:04 diagnostic code, DX5 variable name)	(same as above)	(same as above)
E: Urinary Problems/		
Pyelonephritis (08:30 diagnostic code, DX1 variable name)	Diagnosed condition is always classified severe	
F: Joints/		
Rheumatic fever 12:30 diagnostic code, DX4 variable name)	Diagnosed condition is always classified severe	
Infectious Arthritis (10:30 diagnostic code, DX1 variable name)	Diagnosed condition is always classified severe	
G: Fever/		
Fever with other symptoms (12:02 diagnostic code, DX2 variable name)	Diagnosed condition is always classified severe	

Malaria (12:04 diagnostic code, DX4 variable name)	Diagnosed condition is always classified severe	
Fever no other symptoms (12:01 diagnostic code, DX1 variable name)	Temperature 39.0° C axillary or greater for children 0 - 2 years. Temperature 40.0° C axillary or greater for subjects greater than 2 yrs. old.	TEMP TEMP
Fever no other symptoms (12:03 diagnostic code, DX3 variable name)	(same as above)	
H: Accident and trauma/		
Burn diagnostic code, BURN variable name)	1st degree covering at least 30% of body OR 2nd degree covering at least 20% of body or involved area includes the head OR 3rd degree covering at least 10% of body or involved area includes the head	DEGREE1 & PERCENT DEGREE2 & DEGREE3 & PERCENT; AREA
Bone injury (09:03 diagnostic code, INJURY variable name)	Bones involved include long bones skull, pelvis, or spinal cord AND schedule F is NOT completed	INVOLVED
Accident (ACCIDENT variable name)	Head injured	DESCRIBE
Laceration (01:08 diagnostic code, LACERATION variable name)	Location includes head AND treatment repair = 1	LOCATION TREAT 7
I: Skin/		
Scabies (01:05 diagnostic code, DX4 variable name)	Generalized = 1 defined as ≥50% body area	SKIN 4
Measles (11:01 diagnostic code, DX2 variable name)	Diagnosed condition is always classified severe	
Abcess (01:02 diagnostic code, DX7 variable name)	Diagnosed condition is always classified severe	
Impetigo (01:01 diagnostic code, DX5 variable name)	Generalized = 1	SKIN4
Chicken pox (11:05 diagnostic code, DX3 variable name)	Temp. greater than 39.0° C axillary	TEMP

Rash (SKIN2 variable name)	Any diagnosis if this symptom appears with a temperature 39.0° C axillary or greater	TEMP
Any skin diagnosis with the symptomas Inflammation: cellulitis (SKIN 26 variable name)	Cellulitis classifies any skin diagnosis severe	

3. Illness Subroutine

The original CRSP design called for an illness subroutine for significant illnesses occurring in target individuals, in which the individual would be visited every other day during the illness to record food intake, weights (for infants and toddlers), and change in activities (schoolers and adults). Unfortunately, the illness subroutine proved impossible to implement uniformly in the field; thus, these data do not exist in the final data base in spite of the existence of the forms and instructions in the field manual and other project documentation.

4. Mortality

The Egypt project study households experienced a total of 16 deaths: 10 target infants, 4 toddlers, one lead female, and one lead male. Only in the case of several infants who died in the perinatal period in the hospital in Cairo after complicated deliveries, were deaths attended by any medical personnel. The procedure followed to document deaths and likely causes is detailed in the mortality manual and form. In actual fact, only about half the CRSP deaths could be assigned probable causes or contributing causes. In other cases, the family refused to discuss the details of the death. When possible, information from the most recent morbidity recall was used to reconstruct the situation of the individual before death, but even this was not always informative.

C. Quality Control

Quality control procedures in the area of morbidity included: systematic staff training and retraining; a morbidity field manual that served as the guidebook for all field procedures; rotation of interviewers at intervals; weekly staff meetings and troubleshooting; random re-interviewing by independent investigators; and independent review of diagnostic decisions at the level of the completed data collection form. These procedures were the responsibility of the Egyptian senior investigator in the area, Dr. Shaheen, who was also responsible for guiding the educational experience of the young physicians assigned to his department.

Initial training in physical diagnosis reviewed general clinical skills and then focused specifically on nutrition-related problems. Dr. Shaheen, in collaboration with Dr. Otto Sieber of the University of Arizona, provided training in the form of lectures and discussions. Actual field assessments of patients were carried out in Kasr el-Ainy teaching hospital in Cairo. Special lectures were arranged by specialists in dermatology and in otolaryngology. Training in medical history taking and in the morbidity recall protocol involved lectures, demonstrations and role playing with physicians administering the protocols to each other and to other NI staff. Initial training took approximately one month.

Weekly staff meetings of all young physicians with Dr. Shaheen were used for discussion of problems encountered in the field and also for continual training. Problems of standardization were raised and resolved as they arose. The Egyptian Principal Investigator met with the doctors' group at least once a month to participate in training and quality-control discussions.

All training experiences and quality control procedures were developed collaboratively between Egyptian and US counterparts, and so far as possible involved input of the more experienced of the young physicians. Rationale for

quality control procedures was stressed continually. Newer, inexperienced physicians always underwent several months of training at the Nutrition Institute before attempting fieldwork and were assigned to a team with a more experienced physician. Throughout, feedback was provided on the quality of the data and assistance was offered by senior NI staff in solving problems of logistics, field relations, and technical issues.

As training progressed, it became clear that the most difficult type of illness in which to standardize diagnoses among observers was that of respiratory illnesses. Accordingly, the University of Arizona group devised a computer-based approach to auditing the respiratory diagnoses based on presence or absence of various signs and symptoms (see Table 4.14).

Table 4.14.
Computer auditing of respiratory diagnosis

To make a diagnosis, the following diagnostic criteria should be met:

1= Yes (Symptom or sign must be present) 2= No (Symptom or sign should not be present) 3= (Symptom or sign may be present or absent)

Symptom/Sign	Diagnosis						
	Allergy	Asthma	Croup	Pneumonia	Cold	Tonsillopharyngitis	Bronchitis
R1 Sneezing	1	2	3	2	1	2	2
R2 Nasal Discharge	1	2	3	3	1	2	2
R3 Nasal Discharge: purulent	2	2	2	3	3	2	2
R4 Respiratory Difficulty	3	1	1	3	2	2	3
R5 Cyanosis	2	3	3	3	2	2	2
R6 Cough	3	1	1	1	3	2	1
R7 Cough- Productive	2	3	3	3	2	2	3
R8 Cough - Sputum clear		3	3	3			3
R9 Cough - Sputum purulent		2	2	3			3
R10 Cough - Sputum bloody		2	2	3			3
R11 Whoop	2	2	2	2	2	2	2
R12 Inspiratory stridor croup	2	2	1	2	2	2	2
R13 Wheezing	2	1	3	3	2	2	3
R14 Wheezing - localized	2	3	3	3	2	2	3
R15 Wheezing - inspiratory	2	3	3	3	2	2	3
R16 Wheezing - expiratory	2	1	3	3	2	2	3
R17 Shortness of breath	2	1	1	3	2	2	3
R18 Respiratory distress	2	1	1	3	2	2	3
R19 Nasal flaring	2	3	3	3	2	2	3
R20 Retractions	2	3	3	3	2	2	3
R21 Retractions - Supra-Clavicular	2	3	3	3	2	2	3
R22 Retractions- Intercostal	2	3	3	3	2	2	3
R23 Retractions-Substernal	2	3	3	3	2	2	3
R24 Rales - Anterior right	2	2	2	3	2	2	2
R25 Rales - Anterior left	2	2	2	3	2	2	2
R26 Rales- Posterior right	2	2	2	3	2	2	2
R27 Rales- Posterior left	2	2	2	3	2	2	2
R28 Rhonchi- Anterior right	2	3	3	3	2	2	3

Table 4.14. continued

Symptom/Sign	Diagnosis								
	Allergy	Asthma	Croup	Pneu-monia	Cold	Tonsillo-pharyngitis	Bron-chitis	R29 Rhonchi-	Anterior le
R30 Rhonchi- Posterior right	2	3	3	3	2	2	3		
R31 Rhonchi- Posterior left	2	3	3	3	2	2	3		
R32 Throat- red injected	3	2	2	2	3	1	2		
R33 Tonsils present									
R34 Tonsils size	N	N	N	N	N	enlarged	N		
R35 Throat- exudate	2	2	2	2	2	3	2		
R36 Throat- exudate-follicular	2	2	2	2	2	3	2		
R37 Throat- exudate-confluent	2	2	2	2	2	3	2		
Temperature - elevated	2	2	1	1	3	1	3		
Respiratory Rate	N				N	N	N		

IV. SANITATION AND HYGIENE

The household physical environment, especially its level of sanitation and hygiene, plays an important role in the epidemiology and etiology of many illnesses. In the Arab Republic of Egypt (ARE), diarrheal disease, including acute gastroenteritis, presents one of the most important public health problems, particularly among infants and young children. The incidence of diarrheal disease remains very high due to unhealthy practices and conditions such as defecating and urinating in or near streams and canals, lack of potable water, insufficient refrigeration, lack of sanitary control of slaughterhouses, the presence of swarms of flies on practically all edible materials, and improper disposal of wastes and refuse (Furnia, 1975). In rural Egypt, including Kalama, village populations ubiquitously use canal water for bathing, swimming, refuse disposal, laundering clothes, and washing utensils. Thus, villagers unknowingly continue to expose themselves to a highly dangerous source of microbial contamination.

A. Goals and Objectives

The main goals of the project's sanitation and hygiene research activities were to:

1. determine the state or condition of household and individual sanitation and hygiene in all study households.

2. rank households and individuals according to level of sanitation and hygiene.

B. Developing Sanitation and Hygiene Methods for an Egyptian Village

To develop appropriate and realistic measures of the level of household and individual sanitation and hygiene in Kalama, cultural aspects of village life relevant to sanitary and hygienic practices must be understood fully. Not surprisingly, the typically western notion of "cleanliness" invoking images of pristine bathrooms and shining freshly-waxed kitchen floors does not accurately portray the situation in Kalama. Therefore, the design of data collection instruments and the concomitant "hygienic adequacy" scales derived from them must reflect, and be sensitive to, the reality of the Egyptian village.

1. Brief Ethnographic Description of Kalama's Environment Showing Potential Indicators of Hygiene Status

Snaking through Kalama is a narrow S-shaped irrigation canal which is crossed at several points by bridges. In addition to its agriculture-related function, the canal is also used for washing dishes and clothes, as water source for animals, as a disposal place for refuse, and as a summertime swimming area. In fact, village women prefer to use canal water for laundering the family's clothes because of its "whitening" power. Those with electric washing machines can even be seen pushing the equipment from their homes to the bank of the canal on laundry days.

Kalama women and girls are constantly cleaning and scrubbing. They use a variety of scrubbing and cleaning agents to whiten and shine. Water and soap are ever present. So are straw scrubbers or dishcloths and abrasives. They are used to clean the latrine, and the cooking and eating utensils. Common abrasives are aluminum scrubbers, straw, ashes, and sand. Disinfectants are sometimes used to sanitize the latrine.

Governmental water taps are located inside only a minority of homes. Although few families are without a water supply, most have outside water pumps which are communally used by several households. Since most homes are not equipped with indoor plumbing, a latrine or other receptacle requiring evacuation, is the common "bathroom" facility. Individuals commonly carry water into the latrine. Aluminum cups and tin cans are the usual containers, although kollabs and metals bowls are also used.

Infants and toddlers do not wear "diapers." Infants wear swaddling clothes and toddlers wear the gallabeya (long shirt or dress) worn by older children. Infants' clothing is changed frequently. Consequently, mothers and other caregivers spend more time changing and laundering infants' clothing than they do for older children or adults.

Houses are typically one or two-story dwellings constructed of mud or red brick; most have two to three rooms. Dirt floors are firmly packed, but they require occasional spraying with water to control the dust. Unscreened windows and doors remain open; they permit friendly exchanges with kin and neighbors and free entry of flies and bugs.

The open living area of the house is usually used for food preparation and eating. Animals and birds are often stabled or cooped close by. One commonly sees pigeon cages hanging from the ceiling over the cooking area or water cooler.

Few families own refrigerators. Shopping and cooking habits reflect this reality. Women or girls go to the market everyday to purchase highly perishable items. Many other foods are pickled or salted as a method of preservation (e.g. fruits, vegetables, cheese). At the same time, meals are carefully planned to allow for only enough leftovers for the next day's meals.

Dung cakes are manufactured by some families and used as a fuel source. They are made by combining manure and straw, shaping the mixture into brick-sized rectangles, and allowing them to dry. This is the work of women and girls. Dung cakes adorn the roofs of homes while drying; the roof also serves as a good storage place for this fuel.

2. Relevant Indices of Sanitation and Hygiene in Kalama

Based on ethnographic information gathered in Kalama and the requirements of the Nutrition CRSP research design, a decision was made to focus on indicators of sanitation and hygiene at both the household and individual levels. The following eleven indices of household sanitation and hygiene and five indices of individual sanitation and hygiene were identified and incorporated into the project's data collection protocol.

a. Household-Level Indices

- Storage location of cooking and eating utensils
- Care of cooking and eating utensils
- Type and care of latrine
- Laundry practices
- The manufacture of dung cakes
- Uses of boiled water
- Proportion of areas inside house covered with litter
- Types of pests inside and outside house
- Type and number of animals and birds inside house
- Type and number of animals and birds adjacent to house

b. Individual-Level Indices

- Proportion of hands and face covered with dirt
- Number of flies observed around face
- Type of foot protection
- Proportion of clothing covered with dirt
- Presence of light cloth or veil over infant for protection from dirt and other insects

Data would be collected by both interviewing the target female to obtain information on the household's general sanitation and hygiene practices and by systematically observing the home environment and target household members to determine their state or condition.

C. Methods Implemented in the Final Research Design

The sanitation and hygiene research methods developed for the final research design were implemented in the CRSP's case study research in Kalama from December, 1983 to March, 1984. In January, 1984, Phase II research on sanitation and hygiene commenced in all Nutrition CRSP households and continued until December, 1985.

1. Data Collection Instruments

Three research instruments were designed specifically for the collection of sanitation and hygiene data on individuals and households participating in the Nutrition CRSP in Egypt. Two instruments required that data be obtained by observation; the other instrument relied on an interview protocol. These instruments are as follows.

a. Individual Sanitation and Hygiene - Observation Protocol

This protocol consists of observing and recording five separate determinants of individual sanitation and hygiene including:

- Percentage of hands and face covered with dirt
- Number of flies around face
- Type of foot protection, if any
- Percentage of clothing covered with dirt
- Presence of veil over infant for protection from flies, other insects, and debris

b. Household Sanitation and Hygiene - Observation Protocol

This protocol consists of observing and recording five separate determinants of the sanitary of hygienic state of the home environment, including:

- Exposure of cooking and eating utensils to insects and dirt during storage
- Percentage of specific areas of the house covered with litter
- Presence of pests in the house or in the yard
- Number and type of animals and birds located inside the house
- Number and type of animals and birds located adjacent to the house

c. Household Sanitation and Hygiene - Interview Protocol

This protocol consists of interviewing the target female on 24 different components of her household's usual sanitation and hygiene practices. General categories of questioning include:

- Care of cooking and eating utensils
- Type of latrine and its care
- Laundry practices
- Dung cake manufacturing
- Uses of boiled water

D. Personnel and Staff Training

The data were collected by staff social workers at the Egypt Nutrition Institute and recent graduates of Cairo universities. Project staff participated in a mandatory training program to learn to use the data collection instruments, as well as the methods and procedures of the project's sanitation and hygiene research activities. The training program also included the basic principles and strategies of interviewing and systematic observation. Each staff member received a copy of the field manual used in training.

E. Methods

The basic methodologic approach entailed collecting data on individuals and on households using either an observation protocol or the interview method. Using the observation protocol, study participants and targeted areas in the house were systematically observed; data were recorded on the observation instrument. In interview sessions, the target female was interviewed on aspects of sanitation and hygiene practices in her household. Observational data on individuals and houses, and interview data on household sanitation and hygiene practices were collected concurrently by independent data collectors at three-month intervals throughout the duration of the study. The following targets were identified:

- o households
- o adult males
- o adult females
- o school-age children, 7-9 years of age (if applicable)
- o toddlers, 18-36 months of age (if applicable)
- o infants, birth to 6 months of age (if applicable)

F. Data Processing

Sanitation and hygiene data were processed first in Egypt at the Nutrition Institute and Al-Ahram, then in the United States at the University of Kansas. Coding, entry, and verification occurred in both countries, but translation was performed in Kansas only.

1. Translation

Responses to the following four data categories on the Household Sanitation and Hygiene Instrument (Observation Protocol) were anticipated to be extremely specific and variable and thus, were recorded in Arabic during data collection.

- o type of animal(s) observed inside house
- o type of animal(s) observed adjacent to house
- o type of bird(s) observed inside house
- o type of bird(s) observed adjacent to house

Consequently, these data required translation, categorization, and subsequent coding before computer entry.

2. Coding

Trained data processors used the following methodologic approach which entailed systematically performing the following procedure:

1st Categorize data not precoded in the field.

2nd Assign code to categorized data.

3rd Record appropriate code on sanitation and hygiene instrument.

Since these data were coded at both the Egypt Nutrition Institute and at the University of Kansas, variable names differ as do their corresponding codes. These had to be resolved at the Kansas Data Management Unit. Research variables are fully documented in the Data Management Methods section.

3. Entry and Verification

The data were entered twice onto the computer from the data collection instruments. Each entry was performed by a different data entry clerk. Discrepancies between the two entries were detected and corrected by consulting the original data collection instruments.

G. Ranking Households and Individuals According to Level of Sanitation and Hygiene

1. Households

Five point interval scales for ranking households according to level of sanitation and hygiene were developed from data derived from the two Household Sanitation and Hygiene instruments, i.e. observation and interview protocols. Data from 96 households (observation protocol) and 99 households (interview protocol) were involved in this process. Specific components of household sanitation and hygiene could be evaluated singularly or compositely on these scales

The scale ranges from one point (very poor) to five points (very good) with three points as a satisfactory or adequate score.

The household sanitation and hygiene score consists of eight components, each with several indices:

- care and storage of cooking and eating utensils
- type and care of latrine
- laundry practices
- uses of boiled water
- manufacture of dung cakes
- condition of house
- location of animals
- presence and location of pests

The sanitation and hygiene score for each component was calculated by adding the numerical value assigned each index and then dividing by the total number of indices. Thus, bias was eliminated when data for an index is missing.

2. Individuals

Five-point interval scales for ranking individuals according to level of sanitation and hygiene were developed from data derived from the Individual Sanitation and Hygiene Observation Protocol. Data from 90 households were involved in this process. Individuals as well as composite households could be evaluated on these scales.

The scale ranges from one point (very poor) to five points (very good with three points as a satisfactory or adequate score).

The hygiene and sanitation score for all individuals - except infants - consists of four components or indices:

- condition of hands and face
- condition of clothing
- condition of face - flies
- type of foot protection

An additional component was included for infants:

- protective cover with cloth or veil

The sanitation and hygiene score for each individual was calculated by adding the numerical value assigned each of the four indices and then dividing by the total number of indices. Thus, bias was eliminated when a datum for an index is missing.

H. Quality Control Procedures

1. Prior to Data Collection

Sanitation and hygiene research instruments and protocols were developed to complement the research design, research plan, and study hypotheses. The field staff was selected and trained to accurately implement the research instruments in the field. All instruments were developed in English, translated from English to Arabic by one translator and then back to English by another. The Arabic version of each research instrument was field-tested and modified, based on the results of field-testing, until 95% reliability had been achieved. This manual providing step-by-step procedures with examples was developed to accompany the sanitation and hygiene instruments.

2. During Data Collection

The field staff was observed during 10% of observations and interviews. A Senior Investigator determined if the Manual of Operations was being followed, assessed comparability of techniques, identified problems, and ensured consistency in the quality and amount of time spent with respondents or in observations.

Data reliability was also calculated. A Senior Research Assistant re-interviewed or re-observed a 10% random sample of households and individuals selected by the Senior Investigator, and re-collected a sample of the data from the original interview or observation. The questions were selected by the Senior Investigator. The field staff was not given the identity of the respondents or made aware of the data chosen for re-collection.

Information on data collection instruments was verified to ensure that all spaces were filled in correctly. Blank spaces were not acceptable, since they indicated that question(s) were skipped. Fieldworkers were instructed to return to households with missing information to rectify the error. If the relevant information were still not available, the empty spaces were completed with an appropriate code which indicated "could not observe/not applicable."

3. During Data Processing

Inter-translator reliability was assessed on 10% of the data. Two translators were active in translating these data. They produced 100% reliable data.

Inter-coder reliability was determined on an ongoing basis throughout Phase II by calculating error terms on 10% of the processed data. Sanitation and hygiene data collection forms were assessed individually rather than compositely. Coded data form achieved a reliability of 95% or greater.

Data entry quality control was performed by double entering all data, detecting differences, and verifying the final input. Out-of-range values were also detected by a computer algorithm.

I. Descriptive Statistics and Summary of Findings

Interview and observational data on sanitation and hygiene were received on 278 study households. We present below a summary of the data obtained in the first assessment of these households, i.e. at the time a household entered the project. Data are organized as either household level or individual level data. A summary of these results follow.

1. Household Level Data

a. Care of Cooking, Eating and Drinking Utensils (Interview Data)

In 79% of households interviewed, respondents reported that their cooking and eating utensils were washed after each meal or twice per day. The reports further showed that drinking cups were washed after each use in 93.5% of households. Table 4.15 shows that water, soap, a scrubber and/or dishcloth are the principal items used in the cleaning process.

Table 4.15.
Percent households using cleaning supplies in washing cooking and eating utensils

Type of cleaning supply	Households (n=277)	
	Percent	n
Water	99.6	276
Soap	99.3	275
Dishcloth	50.5	140
Scrubber	63.2	175
Straw	50.5	140
Ashes/Sand	1.1	3

b. Latrine (Interview Data)

Virtually all households (99.6%) have a latrine. Table 4.16 indicates that most (78%) are of the ground level seatless type which are located very close to the dwelling. The latrines do not have running water and require evacuation. In 74% of the households, latrine evacuation is performed by a special worker. However, target females in 25% of households report doing this work. Target males perform this activity in only 16% of households. (These are not mutually exclusive).

Table 4.16.
Percent of households with different types of latrines

Type of latrine	Households (n=242)	
	Percent	n
Toilet with reservoir	7.9	19
Flat seatless latrine	78.1	189
Barrel	7.0	17
Hole	6.6	16
Other	0.4	1

Various cleaning devices are used in cleaning the latrine (Table 4.17). Water, of course, is commonly used. This is the case for 84% of households. A variety of cleaning agents and materials are used in cleaning: soap is used in 39% of the households, a scrubber in 30%, and straw in 26%. Only 20% of the households reported using a disinfectant. Most households (87%) reported that they had no problem with foul smells.

Table 4.17.
Percent of households using cleaning supplies in maintaining their latrine

Type of cleaning supply	Households (n=275)	
	Percent	n
Water	84.0	231
Disinfectant	20.4	56
Soap	38.9	107
Scrubber	30.2	83
Straw	25.8	71
Broom/Mop	23.6	65
Cloth	10.5	29
None	4.4	12

c. Laundering Practices (Interview Data)

The family laundry is preferably done in one's yard at home; however, the village canal is popular with some respondents. The site selected often depends upon the type of laundry and the social status of the person performing the task. Heavily soiled clothes are usually laundered in the canal; young girls and older "low status" women often use the canal.

Two thirds of the households (67%) report that they wash the family's laundry two to three times per week (Table 4.18). Almost all households wash at home (94%); 24% wash at the canal.

Table 4.18.
Distribution of households by frequency of washing clothing

Type of clothing	Frequency of washing clothing													
	>1x/day		1x/day		4-6x/week		2-3x/week		1x/week		other		NA	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
General family laundry (n=276)	0	0.0	17	6.2	29	10.5	184	66.7	44	15.9	2	0.7	0	0.0
Toddler's clothes (n=223)	37	16.6	31	13.9	82	36.8	62	27.8	6	2.7	0	0.0	5	2.2
Infant's clothes (n=138)	31	22.5	48	34.8	16	11.6	13	9.4	5	3.6	0	0.0	25	18.1

Most households (88%) report that they wash all types of laundry at home while only 11% wash all types laundry at the canal. Children's laundry and heavily-soiled clothes are mentioned as principal types of laundry cleaned at the canal.

The extra attention required in the care of infants' clothes are reflected in the data. Table 4.18 indicates that while 57% of households reported washing an infant's clothing at least once per day, only 31% reported the same frequency of washing a toddler's clothing. Sixty-five percent of households wash a toddler's clothing between two and six times per week.

Boiling is an important part of the cleaning process; the laundry is either boiled in a large pot on the stove or soaked in boiling water. More than 90% of all households report that they boil water for laundering purposes. Of households with either an infant or young children, 85% reported boiling water for washing the children's clothes.

d. Uses of Boiled Water (Interview data)

In addition to the laundry, many households reported that they boiled water for children's (59%) and adults' baths (60%). It is interesting to note, however, that only one percent of households boil water especially for drinking. On the other hand, most adults drink strongly boiled tea several times each day.

e. Manufacture of Dung Cakes (Interview data)

Table 4.19 indicates that only 31% of households reported collecting manure for making dung cakes, an important fuel in the community. Of these, 72% reported collecting dung cakes every day and storing them principally on the roof of their home. In almost all households (91%), the target female made the dung cakes, usually every day. In 42% of households dung cakes were made with 100% animal manure.

Table 4.19.
Distribution of households by frequency of collecting manure and making dung cakes

Type of activity	Frequency of performing activity													
	Never		1x/day		4-6x/week		2-3x/week		1x/week		other		NA	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Collecting manure (n=219)	151	68.9	49	22.4	0	0.0	0	0.0	10	4.6	3	1.4	6	2.7
Making dung cakes (n=218)	151	69.3	42	19.3	2	0.9	14	6.4	7	3.2	2	0.9	0	0.0

f. Condition of House and Presence of Pests (Observational Data)

Litter, flies, and rodents are often seen in and around children, animals, and houses. This informal observation was substantiated by formal, structured observation. Table 4.20 shows that while a large proportion of observed houses (25.3-47.0%) had no litter in various sites within the home, a majority received a fairly high litter count (25-50%) including the rooms where infants and toddlers sleep and play. Also, as indicated in Table 4.21, rats and flies were observed both inside and outside approximately half of the houses.

2. Individual Level Data

Some infants were protected from flies while they were asleep. Of 141 infants observed, 44% were covered with a veil or light cloth while sleeping; the majority, 56%, were not. In some homes, fans served the dual purpose of reducing the heat and keeping the flies away.

The toddler is particularly vulnerable to contagion with dirt and flies. As shown in Tables 4.22, 4.23, and 4.24, in comparison with infants, toddlers showed more dirt on their hands, face, and clothing and greater numbers of flies on or near their faces. This pattern ceases at the end of toddlerhood. Adult females are similar to toddlers in this respect. Tables 4.22-4.24 show the relative disadvantage of adult females in personal hygiene when they are compared with adult males.

In general, personal hygiene and sanitation improve from the toddler stage through the adult stage but improves greatly in adult males.

Interestingly, Table 4.25 shows consistent progression in protecting the feet, from infancy to adulthood, again with an advantage for the adult male.

Table 4.20.
Distribution of observed households by percent of home living site covered with litter

Living site	Distribution of observed households*							
	No litter		25% covered		50% covered		75% covered	
	#	%	#	%	#	%	#	%
Reception room (n=247)	116	42.6	78	28.7	34	12.5	19	7.0
Room where infants sleep (n=107)	34	12.7	42	15.8	20	7.5	11	4.1
Room where infants play (n=95)	24	9.0	36	13.6	23	8.6	12	4.5
Room where toddlers sleep (n=231)	79	29.0	97	35.7	35	12.9	20	7.3
Room where toddlers play (n=175)	54	19.9	65	23.8	34	12.5	22	8.1

* Calculations are based on two groups, one without litter and the other with litter.

Table 4.21.
Percent of households with pests inside house or in yard

Type of pest	Distribution of households with pests			
	Inside house		In yard	
	Percent*	Number	Percent	Number
Rats	46.4	127 (n=274)	43.2	118 (n=273)
Cockroaches	10.2	28 (n=274)	10.6	29 (n=274)
Flies	46.4	127 (n=274)	52.2	143 (n=274)
Ants	26.6	73 (n=274)	94.1	258 (n=273)

* Observation categories are not mutually exclusive.

Age has both positive and negative consequences depending on whether the individual had made the transition from infancy to toddlerhood or from toddlerhood to some other stage. The toddler stage is an extremely vulnerable one.

Table 4.22.
Distribution of observed individuals by percent of hands and face covered with dirt

Individual classification	Distribution of individuals							
	0% covered		25% covered		50% covered		75% covered	
	#	%	#	%	#	%	#	%
Adult males (n=80)	51	63.7	23	28.7	1	1.3	5	6.3
Adult females (n=274)	154	56.3	88	32.1	16	5.8	16	5.8
Schoolers (n=168)	73	43.5	63	37.5	13	7.7	19	11.3
Toddlers (n=217)	48	22.1	09	50.3	38	17.5	22	10.1
Infants (n=114)	43	37.7	41	36.0	18	15.8	12	10.5

Table 4.23.
Distribution of observed individuals by percent of clothing covered with dirt

Individual classification	Distribution of individuals							
	0% covered		25% covered		50% covered		75% covered	
	#	%	#	%	#	%	#	%
Adult males (n = 82)	54	65.9	23	28.0	2	2.4	3	3.7
Adult females (n = 270)	137	50.7	99	36.7	16	5.9	18	6.7
Schoolers (n = 168)	60	35.7	69	41.1	20	11.9	19	11.3
Toddlers (n = 217)	41	18.9	110	50.7	39	18.0	27	12.7
Infants (n = 115)	39	33.9	49	42.6	15	13.0	12	10.5

Table 4.24.
Distribution of observed individuals by number of flies on or near their face

Individual classification	Distribution of individuals					
	0 flies		1-4 flies		5 or more flies	
	Number	Percent	Number	Percent	Number	Percent
Adult males (n = 81)	75	92.6	3	3.7	3	3.7
Adult females (n = 272)	236	86.8	29	10.7	7	2.5
Schoolers (n = 170)	109	64.1	44	25.9	17	10.0
Toddlers (n = 217)	94	43.3	99	45.6	24	11.1
Infants (n = 117)	76	64.9	27	23.1	14	12.0

Table 4.25
Distribution of observed individuals with or without foot protection*

Individual classification	Distribution of individuals			
	With foot protection		Without foot protection	
	Number	Percent	Number	Percent
Adult males (n = 103)	97	94.2	6	5.8
Adult females (n = 272)	191	70.2	81	29.8
Schoolers (n = 170)	111	65.3	59	34.7
Toddlers (n = 215)	81	37.7	134	62.3
Infants (n = 118)	14	11.9	104	88.1

* With foot protection means individual is wearing shoes, sandals, slippers, socks. Without foot protection implies individual is barefoot.

In summary, the data suggest three trends in an individual's personal hygiene. The first is the apparent intensity of care provided to infants which clearly diminishes as the child reaches 18 months of age. The poorer quality of hygiene observed in toddlers (18-36 months of age) compared with infants reflects this trend.

As expected, infants rely completely on a caregiver (adults and non-adults) for personal hygienic care. However, the toddler is extremely active exploring his/her environment away from caregivers which limits the amount of time and

attention devoted to toddler care. As a result, the quality of hygiene in infants is consistently better than that of toddlers.

The second trend is the gradual but consistent improvement in all aspects of hygiene as an individual ages from toddlerhood to adulthood. As an individual becomes more capable in practicing personal hygiene, his or her degree of cleanliness also increases. Consequently, toddlerhood is the phase in the life cycle which renders the individual most vulnerable to infection, disease and other health problems that are linked to less than adequate hygiene.

A third trend is the gender factor in adults. Adult females are visibly less clean than adult males. (The gender factor in schoolers is being studied). This is consistent with the preliminary "activity" data which show that women not only spend more time working but they also perform many of the dirty tasks such as evacuating latrines and making dung cakes.

J. Reference

Furnia AH. Syncrises: The dynamics of health. XVI: Arab Republic of Egypt. United States Department of Health, Education, and Welfare. Public Health Service, 1975.

V. LABORATORY MEASURES

A. Hematology

1. Sample Collection

Capillary blood samples were collected in the field by project physicians/technicians during home visits. A summary of the schedule of measurements for households and target individuals is shown in Table 4.26. Blood was obtained by finger prick into a capillary pipette (Unopette Microcollection System, Division of Becton-Dickinson, Rutherford, NJ 07070) for hemoglobin measurements and into heparinized microhematocrit tubes for hematocrit and ferritin measurements. Plasma for ferritin measurement was obtained from capillary tubes following the measurement of hematocrit. Blood samples, obtained in the field, were placed immediately into ice chests and transported within 2 hours to the Nutrition Institute Laboratory for hemoglobin and hematocrit determinations on the same day. After hematocrits were read, plasma from hematocrit tubes was transferred to micro test tubes and kept frozen at 20°C until ferritin was analyzed.

Table 4.26.
Summary of the schedule of hematology, urine, and parasitic infection measurements

Subject	Frequency	Hematology*	Urinalyses†	Urine and stool exam for parasites‡
All members of household	Once	x	x	
	1/year			x
Target infant	Birth	x		
	6 mo	x		
Target toddler	Initial & each 6 mo	x		
	Once		x	
	1/year			x
Target schooler	Initial & each 6 mo	x		
	Once		x	
	1/year			x
Target pregnant woman	5th and 8th mo	x	x	
	1/year			x
Target lactating woman	1 and 6 mo	x		
	1/year			x

* Hemoglobin, hematocrit, and ferritin measurements

† Protein, glucose, ketones, pH, and specific gravity

‡ S. mansoni, A. lumbricoides, E. histolytica, H. nana, E. vermicularis, A. duodenale and S. haematobium

2. Methods

Hematocrits were determined by a micro-hematocrit procedure using a Clay-Adams Autocrit II hematocrit centrifuge and reader. Hemoglobin was determined by a cyanmethemoglobin method using the Unopette Microcollection Sys-

tem from Becton-Dickinson. The diluent solution was pre-mixed and aliquoted to minimize dilution errors. This system had proved satisfactory in previous field studies conducted in Egypt. Plasma ferritin was measured in a 10 ul plasma sample by an enzyme immunoassay method with the use of a commercial kit, Spectroferritin, Ramco Laboratories, Houston, Texas.

B. Urinalyses

1. Sample Collection

Urine samples were collected from target subjects of the households according to a schedule based on the date of entry of the household into the study. Samples were collected from each member of the household except children < 3 yr of age at entry, from target pregnant women at 5 and 8 months of gestation and followup urine sampling was done of lead females who agreed to an identification of pregnancy test. Urine samples were collected in specimen containers usually between 10:00 AM and noon and were examined in the field by laboratory technicians. Only urine collected for verification of pregnancy was examined at the Nutrition Institute.

2. Methods

Urine was examined for protein, glucose, and ketone bodies; Uristik was used for the examination of protein and glucose and Ketostik for ketone bodies (Uristix and Ketostix, Ames Div., Miles Labs., Elkhart, IN). Subsequently, urine was examined for pH and specific gravity, in addition to protein, ketone, and glucose by use of Bili-Labstix, Ames Div., Miles Labs., Elkhart, IN.

Urine samples, collected for the verification of pregnancy, were examined immediately after transport from the field to the Nutrition Institute laboratories. A passive hemagglutination inhibition test for pregnancy (UCG-Be-a Stat, Wampole Laboratories, Div. of Carter Wallace Inc., Cranbury, N.J.) was used.

C. Milk Analyses

Volume of milk intake of breastfed infants was not assessed in this study. Preliminary work showed that the test-weighing technique for quantitating milk intake of breastfed infants was difficult to perform in the field setting. Breastfeeding was sometimes as frequent as 18-20 times daily and measurements of milk volume varied in accuracy because of interference with emotionally labile let-down reflexes and certain inconveniences to the mother. Nevertheless, preliminary findings indicated that test-weighing would be the procedure of choice for milk volume assessment of this population

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Energy density measurement of human milk has been the subject of methodological criticism; intra-feed as well as between-feed variability in energy appear to preclude the use of casually obtained milk samples. Lipids provide the major fraction of kilocalories in human milk but are also one of the most variable constituents. Because of the limitations in extrapolating energy concentration of human milk from less than a 24 h collection and also because of the difficulties in obtaining such a sample in the field, energy concentration was not measured in this study. Milk samples were analyzed for concentrations of immune factors, vitamin B-6, and zinc.

1. Sample Collection

Samples of colostrum were collected within 3 to 5 days postpartum and other samples of milk were collected at 8 days and monthly for the first 6 months of lactation. Samples were collected between 11:00 AM and 1:00 PM from the breast determined to be the same as hand dominance of the mother. Samples of both fore and hind milk were collected from the same breast. For example, milk was sampled from the right breast soon after an infant began nursing the left breast and immediately after "let-down." At this time, the mother expressed manually 5 ml of fore milk from the right breast directly into an amber-colored vial which was provided. At the end of the feed, the mother expressed 5 ml of hind milk from the right breast into a second vial. Equal aliquots of fore and hind milk were added to a third vial. This protocol

for milk sampling was used until laboratory data showed that the constituents being measured were of similar concentration in fore and hind samples of milk. Beginning in January 1985, samples of hind milk only were collected. All milk samples were placed immediately in ice chests, transported to the Nutrition Institute and stored frozen at -30°C until analysis or shipment to the USA.

2. Methods

Total vitamin B-6 concentration in milk was determined by a microbiological assay using S. uvarum, based on a method described by Storvick et al. (1), Thiele and Brin (2), Brin and Thiele (3) and Toeffer and Polansky (4). Milk samples were diluted with 0.055 N HCl and autoclaved for 5 hr at 15 psi to release bound vitamin B-6. The hydrolysate was cooled and the pH was adjusted to 4.4-4.6. Samples of filtrate were appropriately diluted with deionized water.

Aliquots of 0.5 to 5.0 ml filtrate and of standard solutions of pyridoxine HCl (PN HCl) were diluted to 5 ml with distilled water and then 5 ml PN-Y-Medium (Difco Laboratories) were added. The mixture was then inoculated with S. uvarum and incubated at 30°C for 22 hr with continuous shaking in a water bath. Turbidity was measured at 550 nm by use of a spectrophotometer and total vitamin B-6 concentrations were calculated with the use of the standard curve.

For zinc analyses, milk samples were diluted 1:10 with 6% butanol and were analyzed by a slight modification of the method developed by Meret and Henkin (5). These researchers analyzed zinc and copper simultaneously and added sodium chloride to enhance the absorption signal for copper. Since copper was not determined in this study, sodium chloride was omitted. All milk samples were diluted 1:100 with 0.1% lanthanum chloride and were analyzed for zinc by use of a Perkin Elmer Spectrophotometer PE 272.

D. Parasitic Infection

Urine and stool specimens were collected in specimen containers from each member of the CRSP households except children < 3 yr of age. Specimens were transferred in ice-chests as soon as possible from the field to the Nutrition Institute for examination. Samples were examined by technicians at the Nutrition Institute on the same day as collected with the use of standard laboratory protocols (6). Stools and urine were examined following sedimentation; stools were stained with MIF solution but no stains were applied to urine sediments.

E. Quality Control Procedures

All laboratory procedures employed standard techniques and whenever possible these were identical across the three country projects. Laboratory notebooks retained records of analyses by subject ID and dates on which the laboratory tests were performed. All assays were done of duplicate samples or of triplicates whenever the sample supply permitted. A quality control plan for laboratory procedures was developed and periodic summaries were made of the results of the system. Records were maintained in such a manner that the results of the quality control procedures could be examined retrospectively when any apparent problem was detected in the data.

Reproducibility of the standard curve was established initially for both hemoglobin and ferritin assays. In the case of screening tests for urinalyses, reliability was established by detection of known concentrations of the substance added to water or a urine sample. Standard deviation of the laboratory error in hemoglobin and ferritin assays was established by replication of the analyses of an externally prepared reference standard in the same assay batch and across batches on separate days. On the basis of these measurements, acceptable ranges were set for the reproducibility of the reference standard as an ongoing control. With each batch of samples analyzed, the reference standard for hemoglobin and ferritin was included to confirm that the results fell within the acceptable range. If the assay was out of limits, it was rerun whenever sample volumes permitted. Reference standards were monitored longitudinally to check for any systematic drift.

As a part of laboratory quality control procedures, a reference sample of ferritin, prepared from a pre-established plasma pool, was also analyzed routinely with each assay on a blind basis. This procedure provided an independent check

of the stability of laboratory procedures and of the limits for acceptable data. After a sufficient number of samples were processed, the laboratory established range limits for assays on an age and sex specific basis. Values for any sample which were outside these ranges were checked/repeated whenever possible.

To implement the interlaboratory quality control agreement, a responsible reference laboratory was designated for each assay and was assigned the responsibility and authority for action. Reference laboratories established procedures for appropriate exchange of "blind" samples at appropriately scheduled intervals, and gave notification of any "out of control" findings to the laboratory/persons involved. The reference laboratory gave whatever assistance was possible to detect the source of the problem, to estimate its duration (i.e. retrospective evaluation of the quality of previous data), and to re-establish "control".

F. References

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VI. COGNITION AND BEHAVIOR[1]

A. Subjects

At the toddler age period subjects were 197 toddlers. Subjects were entered in the project at 17 months of age, and exited the project after the 30th month. Specific details on subject recruitment procedures can be found in the general description of the project.

B. Instruments

At 18 and 24 months, toddlers were administered the Mental Scale and the Infant Behavior Record from the Bayley Scales of Infant Development (Bayley, 1969). In addition, toddlers also received three subscales tapping specific cognitive abilities derived from the Infant Psychological Development scale - IPDS (Uzgiris & Hunt, 1975). The three specific IPDS subscales utilized in this research were: Object Permanence - a measure of memory; Object as Means - a measure of persistence in tool using behaviors; and foresight - a measure of ability to anticipate consequences. Toddlers were also administered a measure of the child's exploratory competence using the toy play codes developed by Sigman. The specific toy play codes utilized are shown in Table 4.27. The test protocol was the same at 30 months except that the Bayley Motor Scale was added while the IPDS measures were dropped. At the 18 month time period 70 toddlers were administered the Bayley Mental Scale, 60 were given the IPDS, 82 were administered the Infant Behavior Record, and 71 were given the Toy Play Measure; at 24 months 71 toddlers were given the Bayley Mental Scale, 78 were administered the Infant Behavior Record, 69 were given the IPDS and 59 were administered the Toy Play procedure. At 30 months, 47 toddlers were given the Bayley Mental Scale, 59 the Bayley Motor Scale, 59 the Infant Behavior Record and 56 the Toy Play measures. However, for the 30 month Bayley Motor Scale, inspection of the data base indicated that the overwhelming majority of scores were out of range. Until and unless this problem can be resolved, the project is not prepared to analyze these data.

In addition, between 18 and 30 months of age toddlers were scheduled for observations twice a month. During observations, an observer coded specific aspects of the toddlers behavior, and the caregivers interaction with the toddler over a 30-minute observation period. Observational codes were derived from those commonly used in infant research in the United States. One hundred seven toddlers had complete observational records between 18 and 23 months; 120 toddlers had complete observational records between 24 and 30 months. A complete list of the observational codes used are shown in Table 4.28.

[1] In addition to toddlers, data was also gathered on infants, school age children and adults. The data for infants have been cleaned and, with some exceptions, analyzed. The infant data (and the methodology used in gathering the infant data) will not be presented in this report due to deadline pressures for turning in the report. The school age and adult data, while collected, have been neither cleaned nor analyzed; nor are these data sets likely to be put into shape for analyzes until further funding is available. Hence, these latter data sets (and associated methodology) will not be presented here.

TABLE 4.27.
Toy play behaviors utilized

Code Name	Code Description
Code 0: No manipulation	Scored when the infant is holding onto a toy, staring into space, or walking around, but not interacting with objects.
Code 1: Simple manipulation	This category refers to simple behaviors involving infant and only one toy. Examples would include mouthing toys, waving toys, or banging toys.
Code 2: Exploration	Exploration refers to specifically looking at the toy while turning the toy.
Code 3: Relational Play	This category involves non-functional combinations of two or more toys. Relational play categories include taking objects out of or putting objects into containers, touching or banging two objects together or stacking one object on top of another.
Code 4: Functional Play	Functional play involves play where the child uses the object in ways that are inherent in the object's function. Function refers to the types of action that are normally associated with the object, such as hitting a spoon against the sides of a cup as if a child were stirring.
Code 5: Symbolic Play	Symbolic play involves evidence that the child is utilizing abstract capacities in its play with objects.
Code 6: Social Play	Social play involves the child showing an object to an adult or attempting to get the adult interested in interacting with the child and the object.

TABLE 4.28.
Description of observational codes

Code Name	Code Description
# of people in home	Coded as the number of people in the same room with the child, or the number of people within five feet of the child if the child was outside.
Responsible caretaker	Coded as the adult or older sib who is closest to the child, and who has responsibility to check and see if the child is safe.
Mother within reach	Coded as the number of times the mother can reach over and touch the child without moving from where she is.
Caregiver within reach of child caregiver	Coded as the amount of time the designated can reach over and touch the child without moving.
Child location	Coded as where in the village the child is after every five minutes.
Active social involvement	Coded as the number of five minute coding units the child is actively involved in some type of activity with adult, sibs or peers.
Object involvement	Coded as the number of five minute units where the child is actively involved in playing with some object.
State of the child	A 4-point code ranging from child irritable, to child wide awake and alert, through child drowsy, through child falling asleep.
Physical contact - amount	Coded as the number of times during the observation the child is picked up, held, or carried by an adult or older sib.
Duration of contact	Coded as the amount of time the child is picked up, held, and carried.
Carrying while doing	Coded as the amount of time the child is being held or carried while the carrier is doing something else not involving the child.
# of spontaneous vocalizations	Coded as the amount of time an adult or older sib spontaneously vocalizes or talks directly to the child.
Verbal responsivity	Each time the child vocalizes, the observer coded whether adult or older sib did not respond to the child's vocalizations within 3 seconds, responded non-verbally (touching the child) within 3 seconds of the child's vocalization, or responded verbally to the child's vocalization within 3 seconds of the child's vocalization
Responsivity to distress	Each time the child showed distress the observer recorded the amount of time before a caregiver responded to the child's distress
Effectiveness of response	Each time the child showed distress, the observer coded whether the caregiver's intervention was effective in soothing the child.
No response to distress	Coded as the number of times a child showed distress and no one responded to the child.

C. Procedures

1. Training Procedures

Training on the Bayley Scales, the IPDS, and the Toy Play Measures were accomplished in a sequential order. First, the Senior Egyptian Psychologist (Feisal Yunis) came to the United States for a month to be trained by the Senior U.S. psychologist (T.D. Wachs). Training in the United States was accomplished through having Dr. Yunis go over test manuals, observe videotapes of infants being tested, watch demonstrations of infants being tested, and then test infants under the supervision of Dr. Wachs. After each testing, specific critiques were made of Dr. Yunis' performance. This training procedure continued until Dr. Yunis was scoring within three points of scores obtained by Dr. Wachs on the Bayley Scales, within 1 point on the Infant Behavior Record, within one stage level on the IPDS Scales and within 5 seconds agreement on the Toy Play Measures.

In the second stage of training, Dr. Yunis returned to Egypt and trained Egyptian masters level psychology graduate students on the specific cognitive testing procedures utilized. After agreement between students and Dr. Yunis reached pre-set levels, Dr. Wachs went to Egypt to cross-check the students' performances. Specific suggestions were made and incorporated into subsequent training.

Measures of inter-examiner reliability were obtained during two subsequent visits by Dr. Wachs to Egypt. For the purely cognitive measures, cross- validation indicated satisfactory interexaminer reliability was being maintained in Egypt during the course of the study (ie., percent exact item agreement was 91% on the Bayley Mental Scale and 86% for the Bayley Motor Scale). For the Toy Play Measures, results indicated satisfactory reliability for 4 of the measures. Specifically, for simple manipulation, exploration, relational play and functional play, the mean interobserver reliability as cross-validated in Egypt was .82 (range .69 - .94). For symbolic and social play these behaviors occurred too rarely to allow us to estimate interexaminer reliability. Less satisfactory interexaminer reliability data was obtained for the Infant Behavior Record. Specifically, for only two of the IBR codes (person responsiveness and fearfulness) could we cross-validate satisfactory levels of reliability (.82 for person responsiveness; 78 for fearfulness). Three other IBR codes obtained borderline levels of inter- examiner reliability (responsiveness to examiner: r =.68, tension: r = .64, reactivity: r = .64). For the remaining five IBR codes, we were unable to cross-validate reliabilities originally obtained in the United States. As a result, the majority of IBR scales must be considered as questionable, in terms of their utility as outcome variables.

2. Training of Observers

A similar sequential procedure was followed for training Egyptian field personnel in obtaining observational data for toddlers. Specifically, the Egyptian Senior Scientist in charge of this aspect of the project (Dr. Zeinab Bishry) came to the United States for three weeks to be trained by the U.S. Senior Scientist (T.D. Wachs) on observational procedures. Training involved Dr. Bishry learning the observational codes to be utilized, followed by Dr. Bishry's viewing and coding videotapes of caregivers and children interacting. Once satisfactory scoring was obtained on videotapes, actual visits were made to homes of American infants in the same age range as those to be studied in Egypt. After each visit, Dr. Wachs went over scoring with Dr. Bishry, correcting problems that occurred in her scoring. At the end of the training period, Dr. Bishry had achieved a minimum interobserver reliability of .85 across all observational codes.

In the second stage of training, Dr. Bishry returned to Egypt and trained her field director (Dr. Afaf Sobhy) in the specific codes utilized. Once Dr. Bishry and Dr. Sobhy had together achieved a reliability criterion of .85, they then trained a larger group of dietitians in the specific observational procedures utilized. Once satisfactory agreement between the field team and Drs. Bishry and Sobhy had been obtained, Dr. Wachs went to Egypt to cross-check performance. Specific suggestions were made and incorporated into further training. Interobserver reliabilities were obtained during subsequent trips to Egypt by Dr. Wachs. Cross-validation results indicated high inter-observer agreement for observer ratings of toddler behavior and toddler caregiver interactions. Specifically, the mean interobserver reliability correlation was .93, with a range from .58 through 1.0. (For 1 variable-nonresponse to distress-occurrence was too rare to allow us to establish reliability).

3. Testing Procedures

The Bayley Mental Scale was administered at 18, 24 and 30 months by masters level psychologists trained by Drs. Wachs and Yunis. The 18 and 24 month Mental Scale was given as part of a battery including the Uzgiris-Hunt and Toy Play examinations. The Mental Scale was administered after the Toy Play exam, with the order of administration varying between the Mental Scale and the Uzgiris-Hunt. Standard administration procedures, as described in the test manual (Bayley, 1969), were used. Specifically, the observer started testing the child with items approximately 1 month below the child's chronological age. Once 10 items in a row had been passed (floor), the observer continued testing until 10 items in a row had been failed (ceiling). No Bayley items were changed from the manual, though all directions were given in Arabic. Testing was done only at times when the children were in an awake active state and were not suffering from any major physical problems. The following modifications were made in test procedure to accommodate local conditions. All testing was done in the child's home in whatever room the parents wished us to test in. During testing the child sat either on a bench type sofa or on the floor. Because some children liked to leave the room, it was necessary to close doors to the outside. Since sibs and family members were sometimes in the room, it was often necessary to have a second examiner present, to keep sibs or adults from interfering with test administration. However, between items, the children were free to interact with sibs and family members. For certain items, such as tower building, which required a hard surface, if the child were sitting on the bench sofa he was moved to the floor. In addition, certain other items were administered even though few children succeeded in them. The main problem here were items involving picture-naming. In part, this was due to children's unfamiliarity with many of the pictures. In addition, part of the problem appeared to be that the children seemed not to comprehend the idea of naming objects seen in a picture. That is, the children could easily name objects that were shown to them, but when they were shown pictures of objects they were unable to name the pictures. Since we were not comparing children with US norms, this problem with picture naming should be a constant bias, and should not affect the Egyptian correlational results.

At 30 months of age the Motor Scale was administered as part of a battery including the Bayley Mental Scale and the Toy Play examination. The Motor Scale came last in the sequence. Standard procedures, as described in the test manual (Bayley, 1969), were followed with the following modifications. All testing was done in the child's home. During testing, children either sat on a bench type sofa, or were free to roam around the room the child was being tested in. Because some children attempted to leave the test situation, it was necessary to close outside doors. In addition, during 30 month testing, it was often necessary to have a second examiner present to keep adults or older sibs, who were often in the room with the child, from interfering in the test procedures. For the 30 month motor scale, because not all homes had stairs, and because logistics made it impossible to bring equipment like portable stairs and walking boards into the home, certain items had to be dropped. Specifically, for the 30 month administration examiners started with item 45 and continued through item 52. Examiners than administered items 57 through 61, item 65, item 68, item 71, item 73, item 75, item 77, item 79 and item 81. Items 53 through 56, 60 through 64, 66 and 67, 69 and 70, 72, 74, 76, 78, and 80 were dropped, because these items called for equipment such as stairs which were not available.

For the IBR, the examiner rated the infants behavior on the specific scales utilized, immediately after the testing sessions were finished. No modifications were made on standard procedures.

The IPDS was given at 18 and 24 months of age. The IPDS was given as part of a battery including the Bayley Mental Scale and the Toy Play situation. The IPDS always followed the Toy Play examination, and was given either before or after the Bayley depending upon examiner judgment. Three scales from the IPDS were given: 1) object permanence, 2) development of means, 3) foresight. Administration was as described in the IPDS test manual (Uzgiris-Hunt, 1975), with some modifications. For foresight, in addition to the two foresight scales listed in the IPDS manual (beads and cup, and stacking toy), to give the foresight scale more range, three additional items contained in an earlier form of the scale were also administered. Two of these items (overcoming an obstacle and three objects) were placed below the beads and cups and stacking toy, while the third (match box) was placed above beads and cup and stacking toy, in terms of order of difficulty. All testing was done in the child's home, with the child in a room designated by the parent. The child sat either on the floor or on a bench-type sofa. As with the Bayley, outside doors were closed and a second examiner was present when other family members or sibs were likely to interfere in testing. For object permanence, the examiner started with single invisible displacement. If failed the examiner went down to visible displacements and

continued until the child had succeeded. If the child passed single invisible displacement the examiner continued up the scale until the first failure. A similar procedure was used for objects as means, with the examiner starting at locomotion and continuing either up or down, depending upon the child's performance, until the child had reached his highest level of performance. For foresight the examiner started at three objects and continued up or down, depending upon the child's level of performance.

Toy play examinations were given at 18, 24 and 30 months. All examinations were done in the child's home. Toy Play always proceeded examination of the child on the IPDS and/or Bayley Scale. During Toy Play examination the child sat either on a bench type sofa or on the floor. Very often adults or older sibs were in the room. At these times, a second examiner was necessary to keep the adult or sibs from interfering in the child's Toy Play patterns. Although the doors to other parts of the house were closed during toy play examinations, the child had freedom to move around the room during the toy play examination. For Toy play, toys were purchased in Cairo; these toys, in the judgment of Egyptian personal, would be familiar to the Egyptian village toddler. To initiate toy play, eight toys were placed in a semicircle around the toddler. The examiner did not initiate interaction with the toddler and requested the caregiver not to do so. Caregivers were allowed to respond to the toddler's overtures. The testing period lasted 15 minutes, with the examiner recording toddler behavior with toys as they occurred. If after 5 minutes the child had not touched a toy, the mother or caregiver was asked to interest the child in a toy. The child's first interaction with this toy were not recorded but all subsequent interactions with toys were.

4. Procedures for Observational Measures

As noted earlier, observations were scheduled to be taken twice a month for a period of 30 minutes per observation. Prior to actual data collection, observers were asked to visit families several times to get the family and child used to being observed. Caregivers were informed that we were doing the observations simply to watch the child in its day to day activities. Caregivers were requested to go about with their daily activities as if the observers were not there. Although there were attempts initially by caregivers to "show off" the child or to formally entertain the observers, as in offering tea, over time these behaviors dropped out and caregivers went about their daily routines.

During the 30-minute observation, the observer recorded the number of caregiver's vocalizations, the amount of physical contact, the duration of physical contact, the verbal responsivity to the child's vocalizations, and the caregiver's response to child distress. After every five minutes of observation, the observer recorded the number of people in the home, the designated caregiver, whether the mother was within reach of the child, the child's location, the amount of the child's social and object involvement, and the child's characteristic state.

D. Statistics

In terms of psychological criterion variables, the following decisions were made. For the Bayley Mental Score, given the variability in time of administration, infant scores were accepted if they were obtained in the time periods when the child was 18 to 19 months, 24 to 25 months or 30 to 31 months of age. Scores above or below these age brackets were not utilized. Given the impossibility of utilizing U.S. norms, the specific Bayley Mental Score criterion variable was the number of items passed by each child. For the Bayley Motor Score, children whose motor scores were taken when the child was 30-31 months of age were accepted. Again, the number of items passed was the prime criterion variable. For the Infant Behavior Record, the same age brackets were utilized as for the Bayley Mental Score; the child's raw score for each code was the outcome variable.

For the IPDS, the same age brackets used for the Bayley Mental Score were also used. Normally, scoring on the IPDS is based on the highest item the child can pass on each scale, given that these scales are designed to be ordinal in nature. For the IPDS, it became obvious from a preliminary inspection of data that the ordinality of scoring found in U.S. populations did not occur in the Egyptian population. Ecological conditions may have resulted in the lack of ordinality - for example, in the development of means task, rather than being placed in a high chair, the child had to be held by an adult or sib; some children took this restraint as a message that they could not play with the toys. Because the ordinality of the scales does not hold in Egypt the following scoring scheme was adopted. For all three scales of the IPDS,

once the child passed an item on a subscale, we assumed the child could pass any items below this one and gave the child credit for all items below the item passed. All items above the first success were then tested. The score for each subscale then became the total number of items passed, rather than the highest level score.

For the Toy Play measures, 7 variables were obtained. For Toy Play, each time the child interacted with an object utilizing one of the codes shown in Table 4.27, the observer coded the child's actions. Codes were scored only if the child changed toys or changed specific actions. Two global categories of scoring were utilized. The first - amount of toy play behavior- coded the total number of different actions with objects used by the child. This score was the sum of all toy play categories shown in Table 4.27, except for no manipulation. The second major category was the percent of time the child showed toy play behaviors in each of the categories shown in Table 4.27. This score is obtained by dividing the number of occurrences for each specific code by the total amount of toy play. This gives us the percent of time the child showed no manipulation, simple manipulation, exploration, etc. The same age brackets used for the Bayley Mental Scores were also used for the Toy Play procedures.

To use observational data as either predictors or criteria, within each observational session for data that were taken continuously (ie., number of vocalizations to the child), the score was the amount of occurrence. For data that were taken every five minutes, the score was either the average across the observation (ie., average number of people in the home across the observation) or the percent of time the child was engaged in a specific activity (ie., the percent of scoring periods within an observation the child was scored as showing either active social involvement or active object involvement). To increase the reliability of the observational data, within-session data were aggregated (summed) across time blocks. For the present analysis, data were aggregated across 6-month time blocks so that a child's observational scores were the sum of specific individual observations between 18 to 23 months and between 19 to 24 months. In establishing the six month time blocks individual children's records were accepted only if the child had a minimum of four observations across at least three separate months during a six-month time block.

Six criterion variables were obtained from the observational data base. These were: child's location (a proxy for child's activity level), percent of time child showed active social involvement during observations, percent of time child showed active object involvement during observations, percent of time the child was in each of the states described in Table 4.28, the total amount of child vocalization, and the amount of active distress. Total amount of child vocalization was obtained by summing the raw scores for no response to child's vocalization, nonverbal response to child's vocalization, and verbal response to child's vocalization. Distress was obtained by summing the numbers of caregiver responses to the child's distress.

The specific predictor variables included the amount and duration of physical contact with the child, the amount of time the person handling the child was also engaged on other activities, the number of spontaneous vocalizations to the child, the percent of child vocalizations that were responded to, the time it took the caregiver to respond to the child's distress, and how effective the caregiver was in soothing the child.

The results reported show descriptive statistics for each of the psychological variables described, correlations between food intake and outcome, correlations between morbidity and outcome, and correlations between caregiver- child interactions and outcome.

E. References

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VII. REPRODUCTION/LACTATION

A. Identification of Pregnancy

Pregnant women whose stage of gestation was estimated to be less than 4 months were identified among the study population and also nonpregnant lead females who were at high risk of becoming pregnant, i.e. newly-weds and those whose birth interval since their last pregnancy was 12 or more months. To aid in the early detection of pregnancy, physicians obtained menstrual status information from lead females during the weekly visit for morbidity recall. Also, an identification of pregnancy questionnaire was administered monthly by physicians and whenever the lead female agreed, a pregnancy test (UCG-Lyphotest, Wampole Laboratories, Division of Carter-Wallace, Inc., Cranbury, New Jersey 08512) was given. Women who were known to be pregnant or who showed a positive pregnancy test and who were estimated to be <4 months of gestation were invited to enroll in the study. Menstrual history/pregnancy questionnaires were used by physicians to estimate the date of conception. The first day of the last menses was recorded either by noting the exact calendar date or by use of a calendar of events.

B. Reproduction and Lactation/Infant Feeding Histories

Soon after the enrollment of pregnant women into the study, reproduction and lactation/infant feeding histories were obtained by trained personnel. The histories provided information concerning parity, numbers of living and dead children, infant feeding practices, i.e. breast feeding, type and time of introduction of supplementary foods, and weaning practices. Information about supplements which the mother considered beneficial or harmful was obtained regardless of whether or not the supplement was given to her infant. Information was also collected about feeding practices when the infant was sick, especially with common illnesses, i.e. diarrhea, fever, and upper/lower respiratory changes. Data, obtained from multiparas, included: the age of weaning of the previous infant; months of combined lactation and pregnancy; and the interval between the present and the previous delivery. To minimize intrusion into the homes, this information was usually collected at the time other data were obtained.

C. Pregnancy Monthly Visits

After pregnancy was confirmed, pregnant women were interviewed weekly by a physician for the occurrence of early symptoms and changes including nausea, vomiting, food cravings or aversions, and also changes in activity. From the third month of gestation, pregnant women were examined monthly by physicians. Lower limb edema was assessed by indentation of the skin behind the medial malleolus following manual pressure for 5 seconds. Blood pressure was measured twice and the second reading was recorded; whenever a value exceeded 140/90 mm Hg, the case was referred for medical supervision. Fundal height was estimated by the physician by examination of the patient in the recumbent position, and the measurement was related either to the symphysis pubis, umbilicus, or the xiphisternum, according to the stage of gestation. Fetal heart sounds and movements were also assessed by the physician and recorded. In addition to the monthly visits by physicians, weekly morbidity recalls and physical examinations were made of women at entry, following delivery, and at exit. A schedule of various measurements made during pregnancy, lactation, and early infancy is summarized in Table 4.29.

D. Laboratory Measurements

Blood and urine specimens were obtained at 5 and 8 months of gestation and at 1 and 6 months of lactation usually between 10:00 AM and noon. Urine specimens were analyzed for protein, glucose, ketones, pH, and specific gravity according to the procedures described previously. Capillary blood was obtained from a finger stick by a physician/technician for hematocrit, hemoglobin, and plasma ferritin measurements. Samples of colostrum/milk were collected within 3 to 5 days postpartum, at 8 days, and then monthly for the first 6 months of lactation. Other details of sample collection and methodology are described in the section on Laboratory Measures.

E. Anthropometry

Except for infant weights which were measured by trained dietitians, all anthropometric measurements were performed by a team of physicians. The training and quality control procedures were described previously.

F. Notification and Follow-up of Newborns

A system was developed to obtain early information about newborns, i.e. within 48 h after the delivery. From a master schedule of the expected delivery dates, physicians/dietitians planned daily visits to pregnant women during the last month of the pregnancy. Birth notification was also given to project personnel by village informants, usually the dayas (who delivered most infants in the village) or health center personnel. A physician arranged a visit to the home within 72 h ± 24 after the birth to perform the Dubowitz assessment. The schedule of subroutine measurements of the infant and mother following delivery was:

Measurement	Age of infant
Infant	
Weight	24 h ± 24; 8 days
Length	8 days
Skinfolds:biceps & triceps	8 days
Circumferences: head & mid-arm	8 days
Clinical Examination	8 days
Dubowitz score	72 h ± 24
	Postpartum
Mother	
History of delivery	24 h ± 24
-hemorrhage	
-abnormalities of delivery	
-attendants at delivery	
Clinical Examination	8 days
Anthropometry	8 days

G. Pregnancy Outcome

Pregnancy outcome data were collected by a trained dietitian within 48 h after the termination of pregnancy, whether the pregnancy ended in fetal death, still birth, or delivery of a live infant. Information about fetal deaths was sketchy because mothers were either sensitive about discussing the events or refused to give information.

Weights of newborns were measured by trained dietitians not later than 48 h after the birth. When mothers refused to allow their infants to be undressed, infants were weighed with their clothes and coverings and then similar clothing was weighed and subtracted to estimate the nude weight. A battery operated K-tron electronic scale, 30 kg capacity and ± 1 g accuracy, was used to weigh infants. The scale automatically averaged weights over four readings which improved the accuracy of weight data for active infants. Other anthropometric measurements were done at 8 days and monthly for 6 months by physicians trained in the procedures.

H. Dubowitz Assessment

Dubowitz scoring for the assessment of gestational age of newborns was done by physicians within 72 hours after the delivery. The protocol for the Dubowitz assessment was based on both neurological and external criteria described by Dubowitz et al. (1). Physicians were trained to perform the Dubowitz assessment by an Egyptian physician who received prior specialized training at the University of Arizona in the assessment. Training sessions with the physicians included the use of a) a videotape (2), b) library materials (1) and c) actual assessment of infants in Cairo hospitals.

Table 4.29. Schedule of measurements during pregnancy and lactation and the first six months of infancy

Measurement	Reproduction Form No.	Stage of Pregnancy, Mo: ENTRY 0	1	2	3[a]	4	5	6	7	8	9	Lactation/Infancy, Mo: B[b]	8d	1	2	3	4	5	6	EXIT
Pregnancy Identification	A	[x	x	x	x]															
Reproduction History	1	[x	x	x	x][c]															
Lactation History	2,13	[x	x	x	x][c]															
Pregnancy Outcome	4											x								
Dubowitz Assessment	5											x								
Food Intake																				
Mother		[x	x	x	x][d]	x	x	x	x	x	x			x	x	x	x	x	x	
Infant																				
Feeding practice	7													x	x	x	x	x	x	
Supplements	8													x	x	x	x	x	x	
Anthropometry																				
Mother	6	[x	x	x	x][d]	x	x	x	x	x	x									
	9										x[e]									
	11												x	x	x	x	x	x	x	
Infant	12												x	x	x	x	x	x	x	
Morbidity																				
Clinical Examination																				
Mother					x		x			x			x							x
Infant													x							x
Recall																				
Mother		———	———	———	Weekly	———	———	———	———	———	———									
Infant													———	———	———	Weekly	———	———	———	
Monthly Visit	3	[x	x	x	x][d]	x	x	x	x	x	x									
RMR							x			x				x		x			x	
Biochemical and Other																				
Mother																				
Hematology							x			x				x					x	
Urine		[x	x	x	x][c]	x	x	x	x	x	x									
Milk Sample													x	x	x	x	x	x	x	
Immunity																				
Humoral							x			x				x		x			x	
Secretory							x			x				x		x			x	
Infant																				
Hematology																			x	
Immunity																				
Humoral																			x	
Cell-mediated																			x	
Cognitive																				
Brazelton												x[f]								
Bayley																			x	
Caretaker-child interaction																x			x	

[a]Subjects were entered into the study prior to the fourth month of pregnancy
[b]Date of birth/delivery
[c]One measurement at the time of entry into the study
[d]Number of measurements dependent upon time of entry into study
[e]Weekly measurements
[f]One measurement between birth and 7 days of age

I. Infant Feeding

A lactation/infant feeding questionnaire was administered by a dietitian to collect detailed information from the mother about infant feeding on the 8th day after delivery and then monthly for the first six months. Formula was considered to be a breast milk substitute and a supplement was used to complement breast milk or formula. Thus, formula could be given as a supplement to breast milk. Information was obtained about the age of introduction of supplementary foods during the first 6 months and the types and estimated quantities of supplements which allowed for calculation of the energy/nutrient content.

J. Quality Control

Data collection forms for Reproduction/Lactation were developed for field use, tested in the field, and revised prior to use. A manual was provided with detailed guidelines for the use of the data collection forms to aid in standardization of collection procedures. Data collectors were recruited and given training sessions which included demonstrations and practice with patients in the out-patient clinic of the Nutrition Institute and also observation of data collection in the field.

K. References

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VIII. TIME ALLOCATION

A. Introduction

A major goal of the Egypt Nutrition CRSP was to determine some of the adaptive behaviors and strategies employed by the study's respondents for maintaining caloric equilibrium (in crude measures) when experiencing marginal and moderate food energy deficits. We were particularly interested in the costs (social and economic) of functional adaptation and were challenged to conceptualize, define, and operationalize "adaptive behavioral strategies" in a manner that was culturally appropriate for Egypt. After extensive field testing, we settled on a time allocation field method which captured the culturally sanctioned roles of males and females and documented how much time was spent in performing these roles.

B. Research Objectives

1. To characterize the activity routines of adults and children in the sample.
2. To further characterize the social contexts within which activity routines of adults and children are performed.
3. To further characterize the activity-linked social interaction patterns for target adults and children.
4. To determine:
   a. the amount and proportion of time spent in different types of activities by each target type during a composite 10-hour day every three months for one calendar year.
   b. the amount and proportion of time spent by target males, females, schoolers, and toddlers in economically and socially productive activities at home and away from home.
   c. interrelationships among time allocation patterns, economic productivity, social productivity, and food intake patterns.
5. To describe patterns of time re-allocation under different social-environmental conditions.

C. Approaches to Time Allocation Studies in Kalama - Phase I Pilot Studies

During Phase I, a pilot study on time allocation was conducted to determine the reliability and validity of the recall method for collecting time use data on Kalama residents. The data generated from this study would also be used to better understand the patterns of time use by the four categories of target individuals in the study.

1. Sample

During February and March, 1983 data were obtained on time use of 40 individuals as they performed routine tasks at home and away from home. The respondents were classified according to household economic activity and target status; the targets were distributed uniformly into agricultural and non-agricultural households. Of the 40 respondents, 17 lived in agricultural households and 23 in non-agricultural households. Distribution of the 17 individuals from agricultural households by target type is as follows: 2(12%) target males, 8(47%) target females, 2(12%) target schoolers, and 5(29%) target toddlers. The 23 respondents from non-agricultural households were distributed as follows: 3(13%) target males, 11(48%) target females, 4(17%) target schoolers, and 5(22%) were target toddlers.

2. Methods

Two different methods: (1) observation of activity by investigator and (2) informant recall of activity to the investigator were used on each of the 40 households on two consecutive days. Observation data were collected on Day 1 and recall data on Day 2. Field workers were given stopwatches and a data gathering instrument and were instructed to observe a single target individual for two and one-half hours on Day 1, i.e. from 10:00 - 11:30 a.m. and from 12:30 - 1:30 p.m. They were instructed to record: (i) all activities performed by the target individual; (ii) the appropriate code for the person's body position when performing each activity; (iii) the time of day the target individual performed the activity; and (iv) the amount of time (in minutes and seconds) the target individual spent in performing the observed activity.

The following day, Day 2, a different (blinded) field worker queried the target individual on the previous day's activities. The target individual was asked to report, by recall, all activities performed from 6:00 a.m. to 6:00 p.m., the time of day each recalled activity had been performed, and the amount of time spent in each activity. The target individual was not asked to recall his or her body position when performing the various activities, however. Target females were asked to report the activities of toddlers.

Information obtained by the two methods was tabulated separately and analyzed. Data obtained by the two research techniques on Days 1 and 2 on the same individual were compared.

3. Results

The data showed 56% recall error for the sample as a whole, although targets in non-agricultural households did somewhat better than those in agricultural households. Recall error was defined as the inability of a target individual to recall and report an activity which had been performed the previous day and in the general time period in which that activity had been performed. Recall error did not include recalling activities which were not performed. The error rate was consistently low in three activity categories: (a) food/tea consumption; (b) participating in recreational activities; (c) resting. These activities dealt with personal care or self renewal and are generally scheduled within certain blocks of time each day. Targets of both household types tended to forget routine activities, viz. socially sanctioned domestic activities which are generally expected of them such as feeding children, attending to animals, washing clothes, and preparing food.

The magnitude of the recall error in this preliminary time use study indicated that the recall method was not valid for collecting time use activity data in Kalama. The recall method did not reflect actual behavior, the time in which a specific behavior occurred, or the amount of time spent on a specific activity. In addition, the recall method failed to capture process and outcome, important data for assessing social performance.

4. Implication and Application to the Final Study Design

A well-designed, valid observational protocol would be employed in the final study design. It would capture the ongoing activity of a well-defined sample and also provide information on social interaction, process, and outcome. A new time use instrument and manual with the details of data collection methodology would also be developed for the study's time allocation research.

The data collection schedule would be revised and expanded to capture a more representative sample of each individual's activity pattern. The following changes were made: i) the period of observation would be increased; ii) observations would begin earlier in the day; iii) observations would be conducted on different days of the week over a three month period to capture a representative 10 hour day; iv) data collectors would be well-trained to accurately document each respondent's activities and the amount of time spent in performing the activities, and v) definitions of activity categories would be developed to standardize fieldworkers' categorization of observed activities.

Ideally, two observers would concurrently record activity information to maintain an accurate account of inter-observer reliability. Each would function as quality control check for the other. Field supervision would be extremely important and absolutely necessary.

The time allocation methods developed for the final research design was implemented in December 1983 as a component of the CRSP's case study research in Kalama. The quality of the data generated during this research was good enough to permit incorporation into the semi-longitudinal study design in August, 1984.

D. Time Allocation Methods Implemented in the Final Research Design

1. Methods

The basic methodological approach entailed systematically observing and recording a target individual's ongoing activities in two hour blocks from 8:00 a.m. to 6:00 p.m. or from 9:00 a.m. to 7:00 p.m., for a composite sample 10-hour day every three months for one calendar year. We selected a field approach that was scientifically sound, appropriate to our research goals, yet compatible with field conditions and the available personnel.

Complete activity information required: i) a total of 10 hours of observation per adult (at home or away from home) - from either 8:00 a.m. until 6:00 p.m. or 9:00 a.m. until 7:00 p.m. - divided into five two-hour observation periods on five different observational days, or ii) a total of six hours of home or out-of school observation per school-age child - from either 12:00 p.m. until 6:00 p.mm. or 1:00 p.m. until 7:00 p.m. - divided into three two-hour observation periods on three different observational days.

Saturday, the beginning of the week, and Friday, the end of the week, were mandatory observation days. Any other day(s), from Sunday to Thursday, was chosen to complete the remaining required hours of observation.

a. Data Categories

The following categories of data were recorded in the observation instrument:

- Time
- Activity
- Antecedent Event
- Product/Outcome
- Equipment/Technology
- Location and Site
- Social Context
  - Others present and their relationship to target
  - Type of interaction
  - Event

Except for three data categories - Antecedent Event and/or Other Comments on Activity, Products/Outcome, and Equipment/Technology, all data on the Activity Record were precoded. Responses to the three non pre-coded data categories were anticipated to be extremely variable and required post-data collection coding.

b. Activity Categories

A list of patterned activities performed by adults and children in Kalama, as determined from ethnographic research, was developed and precoded. Components of each activity category were clearly identified to facilitate the work in the field. For example, components of the activity category "attending to illness" include:

- administering first aid
- preparing remedies
- administering remedies
- preparing special diet
- seeking a healer
- nursing

These were incorporated into the Activity Operations Manual and became part of the standard protocol for field implementation when using the Time Allocation Instrument.

2. General Research Procedures

a. Observation focused on the target individual - either an adult male, an adult female, or a male or female school-age child (7-9 years of age) and his or her activities performed at home or fairly close to home, such as in the garden or at the canal during the two-hour observation period.

b. The target adult's activities were observed and recorded during one of these 5 two-hour observation periods:

Period 1 - 8:00 a.m.-10:00 a.m. or 9:00 a.m.-11:00 a.m.
Period 2 - 10:00 a.m.-12:00 noon or 11:00 a.m.-1:00 p.m.
Period 3 - 12:00 noon-2:00 p.m. or 1:00 p.m.-3:00 p.m.
Period 4 - 2:00 p.m.-4:00 p.m. or 3:00 p.m.-5:00 p.m.
Period 5 - 4:00 p.m.-6:00 p.m. or 5:00 p.m.-7:00 p.m.

The target schooler's home or out-of-school activities were recorded during one of the three afternoon time periods (Periods 3-5).

c. Components of each activity category were studied or reviewed by fieldworkers before data collection. There was room for adding new components to an activity category, if needed. In order to preclude duplications at the field level, a field supervisor was solely responsible for making additions while research was in process.

E. Personnel and Staff Training

Time allocation data were collected by a variety of workers who were trained specifically for this research. They had no previous experience in behavioral field research. Their background was in nutrition or social work and most held staff positions at the Egypt Nutrition Institute. Some were recent graduates from Cairo universities and others were female secondary school graduates residing in the research community. All fieldworkers were Egyptian nationals with fluency in Arabic and only slight, if any, knowledge of English. The Egyptian Senior Investigator speaks English fluently and was responsible for translating the instruments into Arabic, recruiting and training staff, and supervising the fieldwork. Back translation to English was performed by a professional translator. All discrepancies were reconciled prior to field implementation.

Thus, we geared our research strategies to the local conditions. Our goal was to obtain totally objective activity data by trained but relatively inexperienced observers using highly standardized and easily implemented data collection procedures. The Activity Record instrument, field manual, and data collection methods were designed to fulfill these needs.

Fieldworkers were instructed to use the Activity Record to complete a two-hour chronicle of all activities performed by the target individual and to record the timing and duration of the observed activity. They recorded specific activity information every minute of the 120-minute observation period.

In addition to the specific activities performed by a target individual, descriptive information was obtained about the activity. Activities were described in terms of the event triggering an activity, the outcome of an activity or series of activities, equipment used in performing the activity, body position, and location of the individual performing the activity, and the social context surrounding the activity's performance.

Each fieldworker received a stopwatch and an Activity Record Manual. The watch was used for accuracy in recording data on a minute by minute basis. The field manual served as an important guide and reference.

F. Data Processing

1. Translation

Precoded data did not require translation. However, responses to three non-coded data categories - Antecedent Event and/or Other Comments on Activity, Product/Outcome, and Equipment/Technology - had to be translated prior to further processing. The three non-coded data categories were anticipated to be extremely specific and variable and were recorded in Arabic during data collection. Consequently, these data required translation, categorization, and subsequent coding at the University of Kansas.

2. Coding

The methodologic approach entailed systematically performing the following procedure:

1st Categorize data not precoded in the field.

2nd Assign code to categorized data.

3rd Transfer data from Activity Record instrument to the appropriate column(s) on the computer input data sheet.

Research support staff at the University of Kansas were trained in the coding process and issued the Activity Record Coding Manual which served as a standard reference for coding.

3. Entry and Verification

Activity Record data coded on computer input data sheets were entered twice, each time by a different data entry clerk. Data were then verified for accuracy.

G. Quality Control Procedures

1. Prior to Data Collection

The Activity Record instrument and manual were developed to complement the Egypt Nutrition CRSP research design, research plan, and study hypotheses. The field staff was selected and trained to accurately implement the research instrument in the field. The Activity Record was developed in English, translated from English to Arabic by one translator and then back to English by another. The Arabic version was field-tested and modified, based on the results of field-testing, until the designated level of reliability had been achieved. The Activity Record Manual, which provided detailed step-by-step data collection procedures with examples, was also translated twice as described above. It included information on quality control procedures to be implemented in the field.

2. During Data Collection

The original procedure paired two independent observers to simultaneously observe and record general activity data on identical target individuals at pre-determined time intervals to detect error and/or inconsistency. However, this method was modified on August 1, 1984. The new method paired the fieldworker collecting general time use data on the target female with the fieldworker observing and recording the target female's child caregiving activities. This procedure yielded two quality control measures: 1) level of reliability between observers, i.e. number of agreements divided by the total number of possible agreements, and 2) an error term, i.e. number of disagreements divided by the total number of possible disagreements (Table 4.30).

Table 4.30.
Quality control results for recording time allocation data

Phase	Level of reliability			Error term		
	Number of agreements	Total no. of possible agreements	Test stat.	Number of disagreements	Total no. of possible disagreements	Test stat.
Recording	19,935	21,060 (n=21)*	94.7	1,125	21,060 (n=21)	5.3

* Case study data

3. During Data Processing

Inter-translator reliability was assessed on 10% of time allocation data. Three individuals were active as translators and produced 100% reliable translated data.

Inter-coder reliability was determined on an ongoing basis throughout Phase II by calculating error terms on 10% of the processed data. Coded activity records were assessed individually instead of compositely. Inter-coder reliablity of 95% or greater was achieved on each coded data collection instrument.

Data entry quality control was performed by entering all data onto the computer twice by different data entry clerks, detecting differences and verifying the final input. Out-of-range values were also detected by computer algorithm.

IX. CHILD CAREGIVING

A. Introduction

Children's mental and social development are as amenable to the social stimulation given by parents and other caregivers as is their physical development to the stimuli of physical activity (Popkin and Solon, 1976). For these reasons, the type and quality of children's interactions with others, especially with mothers or primary caregivers, can contribute significantly to their growth, nutritional status, morbidity, physical and cognitive development, and otherwise general welfare. Conversely, the type and quality of child caregiving performed by parents and other primary caregivers could ultimately be reflected in their children's well-being.

B. Hypotheses and Objectives

The following three principal hypotheses of the Egypt Nutrition CRSP concern the effect of parent's food intake on their child caregiving behavior and ultimately, on the biological and psychological development of their offspring.

- Maternal food intake affects maternal activities for child-care.
- Maternal food intake affects the behavior and morbidity of infants (0-6 months of age) and young children (18-30 months of age) through child caregiving and sanitation activities.
- Parent's food intake affects their behavior toward the school-age child (7-9 years of age).

In order to create the data base for testing these hypotheses, the following objectives were formulated:

1. characterize the child caregiving activities performed by mothers and fathers in the sample.
2. determine local notions of effective and appropriate child care-giving.
3. develop a valid, culturally relevant "child care effectiveness scale" based on objectives 1 and 2.

C. Developing Child Caregiving Research Methods for Kalama: Applying the Project's Time Allocation Research Methods to Parental Care Giving Research

Since time allocation data capture such social behavioral dimensions as individual decisions, personal perspectives, and role performance (Gross, 1984), a derivative of the time allocation research method could be very useful in the investigation and assessment of an individual's performance as parents and child caregivers. In fact, measuring the impact of time allocated to child caregiving has become an important research focus of a number of investigators. Beginning with the classic studies of the Whitings (Whiting, et al., 1966) researchers have attempted to identify and define the family's caregiving role in children's development (DaVanzo and Lee, 1983; Hill and Stafford, 1980; Ho, 1979; Leiderman and Leiderman, 1977; Navera, 1978; Popkin, 1980; Popkin and Solon, 1976; Tronick et al., 1987; Weisner and Gallimore, 1977). Time has surfaced as an important factor in many of these studies.

Earlier experiences with behavioral research in Kalama, i.e. research on Time Allocation/Social Performance, suggested that a similar approach and field strategy might be feasible for studying child caregiving. Therefore, using the project's time allocation research instrument, fieldworkers were instructed to complete a two-hour record of all activities performed by the target female being observed and to also record the timing and duration of each activity for each of the 120 minute observation period. A stopwatch and a field manual were issued to each fieldworker. The watch was used for accuracy in recording data each minute. The field manual served as an important field guide and reference.

Results obtained from five such trials indicated that a method similar to the one in place would be feasible in a study of child caregiving. It was determined that crude child caregiving patterns, including the type, frequency, and duration of the caregiving activity, could be determined from the basic time allocation data. However, these were insufficient for determining the more intricate patterns of child caregiving; the data were particularly inadequate for assessing quality of caregiving in order to further determine "proficiency" in child caregiving. Therefore, a decision was made to devise separate, but similar, research instruments for studying child caregiving behaviors.

D. Methods and Data Categories

Child caregiving behavior categories were selected from the 26 activities developed for the project's time allocation research. This ensured uniformity among the project's general and focused "activity" research. Nine behavioral categories of particular interest to this research are presented below:

- o attending to illness
- o feeding/breast feeding
- o holding or carrying
- o playing
- o practicing personal hygiene
- o preparing food
- o serving
- o "socializing"
- o supervising, instructing, or mediating

Each was operationally defined in the Field Operations Manual.

Two methods, both observational, were employed in studying the 9 child caregiving behaviors: (1) Time Sampling and (2) Event Sampling. The Time Sampling method refers to the recording of the targeted caregiving behaviors as occurring - non-occurring every 30 seconds (The Time Sample) during a predetermined two-hour research period. The Time Sampling method gives further details on the caregiver-child interaction when the targeted behavior occurred. Occurrence rates of child caregiving were largely determined by this method.

The Event Sampling method refers to identifying and recording each of the 9 caregiving events whenever they occurred (The Event Sample) during the predetermined two-hour research period. The Event Sampling method elaborates further on the antecedent event which triggered the caregiver's behavior, i.e. the consequent event. It also elaborates on the child's behavior resulting from the parental/caregiver's action, the location of the caregiver, and the social context of caregiving. Quality of child caregiving was largely determined by this method.

The two methods were administered simultaneously by two trained fieldworkers. Caregiving practices of target mothers and fathers toward the target infant, toddler and school-age child were observed and recorded by the fieldworkers.

E. Content Validity

A panel of Egyptians with expert knowledge of child caregiving behaviors in rural settings was asked to evaluate the data categories and the operational definition of each data category for completeness and appropriateness. Consensus was high on each measure, thus establishing content validity.

F. Personnel and Staff Training

Child caregiving data were collected by project staff who had received training in behavioral field research sponsored by the Nutrition CRSP. Since this research was an extension and modification of the Time Allocation methods we applied very similar strategies in training staff members assigned to this research activity.

G. Data Processing

The approach was identical to that described in the Time Allocation Chapter. Refer to Sections X.F.1, F.2 and F.3 of this chapter.

H. Quality Control Procedures

1. Prior to Data Collection

The child caregiving instruments and manual were developed to complement the Egypt Nutrition CRSP research design, research plan, and study hypotheses. The field staff was selected and trained to accurately implement the research instrument in the field. The data collection instruments were developed in English, translated from English to Arabic by one translator and then back to English by another. The Arabic versions were field-tested and modified, based on the results of field-testing, until the designated level of reliability was achieved.

The field manual which provided detailed step-by-step data collection procedures with examples was also translated twice as described above. It included information on quality control procedures to be implemented in the field.

2. During Data Collection

The original procedure paired two child-care fieldworkers to simultaneously observe and record both methods at predetermined time intervals. An additional method was added on August 1, 1984. The new method paired the fieldworker collecting general time use data on the target female with the fieldworkers observing and recording the target female's child caregiving activities.

This procedure yielded two quality control measures: 1) level of reliability between observers, i.e. number of agreements divided by the total number of possible agreements and 2) an error term, i.e. number of disagreements divided by the total number of possible disagreements (Table 4.31).

As another reliability test, Frequency data were checked against Narrative data. Results of these reliability checks were reviewed by the Project Director and acted upon as indicated by the data.

TABLE 4.31.
Quality control results for recording child caregiving data

Type	Level of reliablility			Error term		
	Number of agreements	Total no of possible agreements	Test stat %	Number of disagreements	Total no. of possible disagreements	Test stat. %
Frequency	70,479	71,280 (n=27)	98.9	801	71,280 (n=27)	1.1
Narrative	788	95 (n=10)	82.9	162	950 (n=10)	17.1

3. During Data Processing

Inter-translator reliability was assessed on 10% of the data. Three individuals were active as translators and produced 100% reliable data.

Inter-coder reliability was determined on an ongoing basis throughout Phase II by calculating error terms on 10% of the processed data. Data collection instruments were assessed individually instead of compositely. Inter-coder reliability of 95% or greater was achieved on each coded narrative record.

Data entry quality control was performed by double entering all data onto the computer, detecting differences, and verifying the final input. Out-of-range values were also detected by computer algorithm.

I. Ranking Target Male and Female Caregivers According to Effectiveness of Child Caregiving

Scales were derived empirically. Three-tiered ordinal scales were developed from the data generated by Method 2 of the child caregiving protocol. Target male and female caregivers were ranked according to their effectiveness in caregiving. The scale ranged from one point (slightly effective) to three points (highly effective) with two points as the intermediate. Data from all core households were involved in the process.

The focus was on caregiver (both parents) and child. A child's behavior, or antecedent event (e.g. child cries) could trigger eleven possible parent-performed caregiving activities. The caregiver's response to the child's behavior, or the caregiving activity, (e.g. picks up child) led to a subsequent response by the child, or the consequent event, (e.g. child stops crying). All behaviors exhibited by the child, both antecedent and consequent events, were combined and classified.

During the scaling process, each antecedent event/caregiving response/consequent event was considered separately. Depending on the individual situation, consequent events were evaluated and labeled positive, negative, or neutral in response to the antecedent event/caregiving response behavior couplet. Caregiving responses to a child's behavior were then ranked according to the proportion of positive child responses elicited by the caregiver's behavior. The percentage of positive responses was calculated by dividing the total number of positive consequent events by the total number of known consequent events.

These data were then compared and child caregiving responses were ranked as follows for each antecedent event:

Caregiving responses eliciting highest percentage of positive child responses	= 3 (Highly effective)
Caregiving responses eliciting intermediate percentage of positive child responses	= 2 (Moderately effective)
Caregiving responses eliciting lowest percentage of positive child responses	= 1 (Slightly effective)

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X. COMMUNITY AND HOUSEHOLD DEMOGRAPHICS AND SOCIOECONOMICS

A. Goals and Objectives

This set of research activities is designed to obtain valid and reliable data on (a) the community as a geographic, social and cultural entity, (b) community and household demographics and (c) community and household socioeconomics.

The specific objectives are to:

1. obtain data on the dynamics of social and cultural life in the study community using objective, systematic field methods;

2. obtain valid and reliable census information to serve as baseline for selecting the CRSP study sample and for assessing demographic changes in the community during the semi-longitudinal study period;

3. systematically and regularly obtain demographic and socioeconomic data for classifying households, for statistical control, and for developing scales to rank households on social and economic criteria;

4. systematically and periodically obtain data on the demographic characteristics of the community, and on community socioeconomic conditions in order to map changes over time;

5. monitor local weather conditions in order to explain seasonal changes in the agricultural cycle, seasonal influences on food availability, nutritional status and patterns of illness, and to standardize RMR measurements;

6. describe the community and its social institutions.

B. Community Assessment and Survey of Social and Economic Institutions

At the study's initiation in Phase I, a Community Assessment instrument was designed to capture all aspects of the social and cultural life of the community, and to record the community's geographic features. The Community Assessment instrument was used throughout the study in order to capture changes occurring in the community during the life of the study. A significant proportion of the data was obtained through direct observation or through participant observation. The data obtained from assessing the community were used to describe the village. Refer to Chapter 2, entitled "The Site."

In Phase I also, the community's social and economic institutions were surveyed by an Egyptian agricultural economist. Using standard social survey techniques, Kalama's social, political, educational, economic, and health institutions were surveyed to obtain quantitative information on these institutions. The quantitative data obtained from the survey of institutions were incorporated with the qualitative data in describing the village.

C. Community Socioeconomics and Weather Pattern

1. Prices and Wages

Data on specific economic aspects of community daily life were obtained on instruments designed for that purpose during Phase II. From November 1983 through December 1985, data were collected monthly on (a) prices of locally grown food, (b) prices of core foods and beverages and (c) wages.

Market prices of locally grown seasonal crops and on animal, poultry, and dairy products were obtained from local farmers' markets. Prices of food and beverage items commonly purchased in Kalama were obtained from local food markets and retail grocery stores.

Typical wage rates for various occupations were obtained by interviewing employer-farmers and private and public sector employers. Word-of-mouth data were verified by checking statistics available through Kalama's agricultural cooperative. Government wage scales were reviewed to verify government wages.

2. Weather Pattern

The Kaliobia governorate's weather center systematically collects and records weather statistics for communities within the governorate. The following weather statistics were obtained from the Kaliobia weather center:

- mean monthly temperature
- mean monthly humidity
- mean monthly rainfall
- mean monthly barometric pressure
- mean monthly wind speed (added in the field)

D. Community Demographics

A comprehensive village census was conducted in Phase I, during 1982-83. The census provided a demographic profile of the research site.

Using social survey research techniques, the heads of all village households were interviewed, and the following data were obtained on each member of every household:

- name
- sex
- date of birth
- age (in years and months)
- place of birth
- literacy status
- number of years of formal education
- primary occupation
- marital status
- relationship to lead male

Following the survey, a map of Kalama was constructed to define the community as a physical entity with geographic boundaries. Individual households were identified, blocks were identified and boundaries drawn, and each household was located and numbered systematically in relation to all other households in the village.

E. Household Demographics and Socioeconomics

1. Developing Household Demographic and Socioeconomic Research Methods for an Egyptian Village

A major challenge to the Egypt project's socioeconomic research team was to identify appropriate instruments and tools for capturing and measuring ongoing social and economic phenomena in Kalama. These instruments had to be objective, culture-specific, and sensitive to the research population in order to accurately assess the social phenomena and develop appropriate indices for social classification.

Early ethnographic work focused on family and social structure, and on the social and economic status indicators in Kalama. This research provided the basis for designing appropriate instruments and field research strategies. Both social and economic indicators of household social standing had to be incorporated into the instrument design in order to capture important dimensions for scaling households on SES.

2. Household Demographic and Socioeconomic Research Methods Implemented in the Final Research Design

The demographic and socioeconomic research methods developed for the final research design were implemented in October 1983 as a component of both the CRSP's case study and semi-longitudinal research in Kalama. The research was conducted in three parts. First, the initial sociodemographic survey on all village households including CRSP study households was conducted from October 1983 to February 1984. Updates of the baseline information on CRSP study households were conducted from August 1984 through September 1985, and from October 1985 through February 1986. The latter included an update of the whole village. An attempt was made to obtain "update data" every six months on each study household.

The sociodemographic survey yielded data on the following:

- household demographic structure
- housing characteristics and domestic assets
- durable household equipment
- household agricultural activities and farm assets
- household expenditure pattern
- household resource base
- brief reproductive histories of adult females residing in household

F. Personnel and Staff Training

Data were collected by staff social workers at the Egypt Nutrition Institute under the direction of the Chief Social Worker. The field staff participated in a mandatory training program on methods of interviewing and to learn to use the CRSP data collection instruments and field manual. Mock interview sessions were held among the staff and sample interviews were conducted on outpatients attending clinics at the Nutrition Institute.

G. Methods

The basic methodologic approach entailed interviewing respondents to obtain information on household demographics and socioeconomics. Principal informants were i) the household head or target male or ii) the wife of the household head or target male. Although questions were directed to these specific adult informants, it was customary for all (or most) adults present during the interview to respond. This practice was not discouraged. In fact, the spontaneous response by the group was regarded as a form of built-in quality control of household data.

Observation methods were also employed to obtain selected data on housing characteristics and to verify reported information on livestock assets.

H. Ranking Households According to Social Standing and Economic Situation

Scales for ranking households by social standing and economic situation were developed in two stages utilizing demographic and socioeconomic data on 192 households, and ethnographic data on the village as a whole. Scores for ranking households into one of three groups (low, intermediate, high) were derived from demographic indicators and from household and farm assets in the first stage. Later, four-tiered ordinal scales were developed from the initial scores to reflect the dynamics of village socioeconomic transformations derived from the ethnographic data.

1. Stage One - Scoring

a. Demographic Indices

Scores based on two major demographic indices - formal education and occupation of the target males - are presented below. Sociodemographic and ethnographic data obtained during Phase I research indicated that these two variables

provide good estimates of social and economic status in the village. Since most women were homemakers and illiterate, female occupation, education and literacy add little or no variance to the data set.

(1) Demographic Index Score

(a) Occupation of target male

Administrator/manager, public sector Business owner/merchant, private sector Landlord, farm cultivator, agricultural Landlord & tenant farm cultivator, agricultural Professional, public sector Professional, private sector Skilled craftsman/merchant, private sector Skilled technician, public sector Skilled technician, private sector	= 3 (HIGH)
Business sales manager, private sector Secretary/clerk, public sector Secretary/clerk, private sector Shop salesman Small merchant/shop owner, private sector	= 2 (INTERMEDIATE)
Hired agricultural laborer, non-technical Hired laborer, livestock care Non-technical helper, public sector Non-technical helper, private sector Tenant farm cultivator	= 1 (LOW)

(b) Number of Years of Formal Education - Target Males

≥ 9 years of formal education	= 3 (HIGH)
6-8 years of formal education	= 2 (INTERMEDIATE)
< 6 years of formal education	= 1 (LOW)

(2) Economic Index Scores

Two independently derived scores capture two sets of economic indices - household assets and farm assets.

(a) Economic Index I - Household Assets Score

Economic Index I captures household assets. This index measures economic rank and is also sensitive to social standing. Its conceptual design depicts the range of domestic items, from the most common to the most prestigious, observed in respondents' homes. The value of these items was determined by the frequency of their occurrence in village households and by local perceptions of their worth. Its conceptual design and score are presented in Table 4.32.

Table 4.32.
Conceptual design for ranking household assets: Economic Index I

Household assets	Household rank based on presence of assets*		
	Low	Intermediate	High
Television (black and white or color)	1	1	1
Butane stove	1	1	1
Electricity	1	1	1
Clay brick house	0	1	1
Washing machine	0	1	1
Radio cassette	0	1	1
Carpet	0	0	1
Reception room	0	0	1
Refrigerator	0	0	1
TOTAL	0-3 points	4-6 points	7-9 points

* One (1) point indicates asset is present in house; zero (0) points indicate asset is not present in house and is scored as follows:

Number of Household Assets Present in House

Black and white TV	= 1
Butane stove	= 1
Electricity	= 1
Clay brick house	= 1
Washing machine	= 1
Radio cassette	= 1
Carpet	= 1
Reception room	= 1
Refrigerator	= 1

(a) Economic Index II - Farm Assets Score

Economic Index II captures farm assets. This index was developed to more accurately rank agricultural and mixed subsistence households by including their farm assets in the formula. The variables include amount of land owned or rented, and number of animals and birds owned or shared. Ownership of farm equipment was not included due to the frequent occurrence of equipment loans and rentals.

The Farm Assets Index is scored as follows.

i. Amount of Land Owned or Rented

>24 qarats[1]	= 3 (HIGH)
1-24 qarats	= 2 (INTERMEDIATE)
No qarats	= 1 (LOW)

ii. Amount of Land Owned

>24 qarats	= 3 (HIGH)

[1] 24 qarats equal one feddan.

1-24 qarats	= 2 (INTERMEDIATE)
No qarats	= 1 (LOW)

iii. Number of Animals Owned or Shared

>6 animals	= 3 (HIGH)
1-6 animals	= 2 (INTERMEDIATE)
No animals	= 1 (LOW)

iv. Number of Animals Owned

>6 animals	= 3 (HIGH)
1-6 animals	= 2 (INTERMEDIATE)
No animals	= 1 (LOW)

v. Number of Birds Owned or Shared

>6 birds	= 3 (HIGH)
1-6 birds	= 2 (INTERMEDIATE)
No birds	= 1 (LOW)

vi. Number of Birds Owned

>6 birds	= 3 (HIGH)
1-6 birds	= 2 (INTERMEDIATE)
No birds	= 1 (LOW)

c. Scoring

Scores based on the Household Assets Index range from 0-3 points (low) to 7-9 points (high) with 4-6 points as intermediate. The score is calculated by totaling the number of relevant household assets present in a respondent's house.

By contrast, both the Demographic and Farm Assets Indices range from one point (low) to three points (high) with two points as intermediate.

The Demographic and Farm Assets scores are calculated by adding the numerical value assigned each of the indices and then dividing by the total number of indices.

2. Stage 2 - Scaling

Review of composite scores based on the three indices for 192 Kalama households (61.5% of all core households) revealed a spread of scores ranging from 1 to 3. Households were classified into four SES groups according to their overall score (i.e. composite score calculated by summing the individual scores from each component index). The scores were broken down as follows:

≥ 1.0 and ≤ 1.5	= Low SES (Group 4)
>1.5 and ≤ 2.5	= Intermediate SES (Group 2 and 3)
>1.5 and ≤ 2.0	= Lower intermediate SES (Group 3)
>2.0 and ≤ 2.5	= Upper intermediate SES (Group 2)
>2.5 and ≤ 3.0	= High SES (Group 1)

Table 4.33 displays the distribution of the 192 core household by SES.

Table 4.33.
Distribution of core households involved in developing scales by SES

SES Group*	Classification	Households (n=192) n	Percent
1	High	28	14.58
2	Upper intermediate	32	16.67
3	Lower intermediate	81	42.19
4	Low	51	26.56

* Numbers in database for SES

I. Quality Control Procedures

Quality control procedures were instituted to ensure data accuracy. These included:

1. Periodic Observation of Field Staff Conducting Interviews.

A Senior Investigator determined whether the manual of operations was being followed, assessed comparability of techniques, and identified problems and inconsistencies in the quality and amount of time spent with respondents. Any problems identified were corrected promptly.

2. Verification of Data Reliability.

A Senior Research Assistant re-interviewed a 10% random sample of respondents selected by the Senior Investigator and administered a sample of the questions from the original interview. These questions were selected by the Senior Investigator. The field staff was not given the identity of the respondents of made aware of the questions chosen for the re-interviews. Acceptable level of reliability was 95%.

3. Cross-Checks within the Interview to Verify Consistency of Responses.

4. Verification of Information Collected on Questionnaires to Ensure that all Spaces were filled in Correctly.

Blank spaces were not allowed since they indicated that question(s) were skipped. Interviewers returned to households with missing information to rectify the error. When the relevant information was not available, empty spaces were filled as directed in the Procedures Manual.

J. Descriptive Statistics and Summary of Findings

1. Demography

A total of 312 households participated in Egypt Nutrition CRSP research in Kalama. The demographic characteristics of the sample are presented in Tables 4.34-4.42.

Household size varies widely ranging from two to 20 individuals. However, the majority of households (63%) consist of five to eight persons (Table 4.35). Nuclear families are the dominant form, represented by 58% of total households (Table 4.34).

Table 4.34.
Distribution of households by composition type

Household composition type	Households (n = 312) Number	Percent
Nuclear	181	58.0
Extended - Type I*	107	34.3
Extended - Type II†	23	7.4
Other	1	0.3

* A multi-generation family consisting of a base family with one married child, his or spouse and/or children.

† A multi-generation family consisting of a base family with married children, their spouses and/or children

Table 4.35.
Distribution of households by size

Household size	Households (n = 312) Number	Percent
1 - 4	44	14.1
5 - 8	197	63.1
9 - 12	59	19.0
13 or more	12	3.8

The age distribution of all study participants at the time of their entry to the project is depicted in Table 4.36. The population is young; 62% of individuals are under 20 years of age.

Table 4.37 presents data on the literacy status of the sample. Excluding those who are underage, the population is fairly evenly distributed between those who can read and write and those who can do neither.

Table 4.36.
Distribution of all individuals in study households by age at entry to project

Age (in years)	Individuals (n = 2,186) Number	Percent
Birth - 10	933	42.7
11 - 20	417	19.1
21 - 30	313	14.3
31 - 40	282	12.9
41 - 50	79	3.6
51 - 60	86	3.9
61 or more	76	3.5

Table 4.37.
Distribution of all individuals in study households by literacy status

Literacy status	Individuals (n = 2,137) Number	Percent
Cannot read or write	747	34.9
Reads only	98	4.6
Reads and writes	690	32.3
NA (underage)	602	28.2

Table 4.38.
Distribution of households by subsistence mode

Subsistence mode	Households (n = 311)* Number	Percent
Agricultural	66	21.2
Non-agricultural	174	56.0
Combined†	15	4.8
Mixed‡	54	17.4
Other	2	0.6

* Data missing on one study household.

† At least two wage earners - one or more engaged in an agricultural occupation and one or more engaged in a non-agricultural occupation.

‡ At least one wage earner engaged in both agricultural and non-agricultural occupations.

Table 4.38 presents the distribution of households by subsistence mode. Over one-half (56%) of the households participating in the study were non-agricultural households. By contrast, 21% of the sample were farmers. A similar proportion of households in the sample (22%) were employed in both agricultural and non-agricultural occupations. This type of distribution with the bulk of the sample operating in non-agricultural activities is indicative of rapid socioeconomic transformation.

Table 4.39 presents the SES distribution of the total sample of 312 households. Approximately equal proportion of respondent households fall into the low SES group (26%) and combined high and upper intermediate SES groups (30%). Almost one-half are classified as lower intermediate. Data from earlier studies indicate that this type of distribution with the bulk of the population in the lower intermediate category, is a fairly good indicator of rapid socioeconomic change. That is, a large proportion of our sample is in this key transitional position, either just having moved from the low SES category or preparing to shift into the upper intermediate SES category.

Table 4.39.
Distribution of households by socioeconomic standing (SES)

SES	Households (n = 311)*	
	Number	Percent
High	45	14.5
Upper intermediate	48	15.4
Lower intermediate	136	43.7
Low	82	26.4

* Data missing on one study household.

Table 4.40.
Distribution of agricultural households by socioeconomic standing (SES)

SES	Households (n = 66)	
	Number	Percent
High	2	3.0
Upper intermediate	5	7.6
Lower intermediate	33	50.0
Low	26	39.4

Table 4.41.
Distribution of non-agricultural households by socioeconomic standing (SES)

SES	Households (n = 174)	
	Number	Percent
High	30	17.2
Upper intermediate	32	18.4
Lower intermediate	73	42.0
Low	39	22.4

Table 4.42.
Distribution of mixed* subsistence householdsby socioeconomic standing (SES)

SES	Households (n = 54)	
	Number	Percent
High	10	18.5
Upper intermediate	9	16.7
Lower intermediate	21	38.9
Low	14	25.9

* At least one wage earner engaged in both agricultural and non-agricultural occupations.

When subsistence mode data are stratified by SES, the socioeconomically transitional nature of Kalama becomes even more clear. Tables 4.40, 4.41 and 4.42 present the SES distribution of agricultural, non-agricultural and mixed subsistence households. The data indicate that agricultural households are at a clear socioeconomic disadvantage with 89% of households falling into the lower two SES groups and only 3% in the high SES group. This compares to 17% of non-agricultural households and 19% of mixed subsistence classified as high SES. We hypothesize that a mixed subsistence mode, as exemplified by households who participate in both the agricultural and non-agricultural sectors, is linked directly to economic and social productivity and stability.

2. Socioeconomic Indicators

Interview and observation data on household socioeconomics were obtained on all project households. The data reported here represent the information obtained during the first visit to study households, i.e. at the time they entered the project. Data are organized as (a) household assets and (b) farm assets.

a. Household Assets

(1) Housing

Tables 4.43 and 4.44 indicate that most families in Kalama reside in a house (63%) with two to three rooms (53%). Most families own their own home (89%); 4% own more than one home. The predominant construction materials in 70% of the houses are clay bricks with either wood beams or ferro-concrete. Glass windows have been installed in only 34% of houses.

The typical house has a separate latrine area (53%), a cooking area at the entrance to the house (57%), and no special room for receiving guests (70%). The house is used principally for lodging (100%) and storage (66%).

(2) Sources of Water and Light

Table 4.45 indicates that a public pump (50%) and a tap inside the house (21%) comprise the primary sources of water for most study households.

The 21% of households with a second water source rely either on the canal (37%) or a public pump (34%).

Table 4.43.
Distribution of households by structure of principal residence

Structure of residence	Households (n = 312)	
	Number	Percent
House	196	62.8
House with barn	63	20.2
Part of a house	39	12.5
Flat	12	3.9
Part of a flat	2	0.6

Table 4.44.
Distribution of households by number of rooms in principal residence

Number of rooms	Households (n = 312)	
	Number	Percent
1	32	10.3
2 - 3	165	52.8
4 - 5	80	25.7
6 or more	35	11.2

Table 4.45.
Distribution of households by primary and secondary water sources

Water source	Households			
	Primary source		Secondary source	
	Number	Percent	Number	Percent
Tap inside house	66	21.2	0	0.0
Public tap	56	17.9	3	4.6
Private pump	32	10.3	16	24.6
Public pump	157	50.3	22	33.9
Canal	1	0.3	24	36.9
TOTAL	312	100.0	65	100.0

(3) Cooking and Baking Facilities

Virtually all households (91%) have only one type of cooking facility, which is principally a small gas stove (61%); 50% have an oven for baking.

(4) Durable Household Equipment

Items commonly found in Kalama households are black and white televisions (66%), washing machines (52%), cassette tape recorders (47%), and radios (38%).

Some households have fans (22%), bicycles (21%), wool carpets (12%), motorcycles (11%), and refrigerators (10%).

A few have a color television (2%), hot water heater (2%), car (4%), sewing machine (8%), electric heater (1%), or blender (6%).

b. Farm Assets

(1) Landholdings

Over three-quarters of the households (81%) do not own or rent land or have land under cultivation.

(2) Animals and Birds

Approximately three-quarters of households own neither animals (75%) nor birds (72%). Donkeys are the most commonly owned animal (25%), and chickens (28%) and pigeons (22%) are the most commonly owned birds. Camels, horses, rabbits, and mules are rarely owned.

XI. DATA MANAGEMENT

A. Introduction

The ultimate goal of the Egypt Nutrition CRSP's Data Management Unit (DMU) is to facilitate the comprehensive inter- and intraproject analyses of the Nutrition CRSP data. In order to achieve this overall goal, Egypt Project data management methods were developed in accordance with the procedures outlined for all three projects in the Nutrition CRSP Revised Research Design - Phase II (June, 1983) and the Nutrition CRSP Basic Data Set (September, 1984). The data management system developed for the Egypt project reflects and complements these procedures. In only a few instances were methods modified to incorporate local customs, facilities and capabilities.

B. Goals

The main goals of the Egypt project's DMU were as follows:

1. Organize and schedule data collection for all research activities to ensure a "complete data set" at the close of the study, i.e. all data collected with the specified frequency on each specified target household and individual throughout the duration of the study.

2. Establish a data quality control system for all data produced by the project.

3. Process, correct, edit, and organize raw data into SAS files.

4. Develop and process derived variables.

5. Document all of the above.

6. Distribute tapes and hard copies of data to investigators, statisticians, and the management entity.

C. Data Management Sites

The Egypt project's DMU was located both on site at the Egypt Nutrition Institute in Cairo and at the University of Kansas Medical Center in the United States. Each site was supervised by a Data Manager, each working collaboratively with her staff, Nutrition CRSP principal and senior investigators, and Nutrition CRSP data managers within and outside of the Egypt project.

D. Organization of Data Management Activities

The Kansas DMU performed all of the data management activities subsumed in the goals during Phase I of the study. At the beginning of Phase II (October, 1983), the responsibility for basic data processing, i.e. entry and correction, was transferred to Egypt. It was determined that the Kansas DMU would further process, i.e. verify data transferred from Egypt on tapes, and organize the data into SAS files for distribution to investigators, statisticians and management. This transition, however, was delayed by complications in establishing the Nutrition Institute's basic data processing operation.

To compensate for potential time loss in data entry and correction, the Kansas DMU agreed to continue the basic data processing activities for all data collected through July, 1984. Data collected from August, 1984 to December, 1985 would be processed in Cairo at the Egypt Nutrition Institute and at Al-Ahram Management and Computer Center using methods developed at the Kansas DMU. Most of the data were to be sent to the Kansas DMU on tapes. Exceptions were photocopies of child caregiving and the time allocation data. All time allocation and child caregiving data collected through December, 1985 were to be sent to the Kansas DMU for processing.

Specific data management methods to achieve the goals are discussed in detail below.

E. Sampling and Field Procedures

1. Sample Identification

Data Management activities for Nutrition CRSP began with the identification of households and targets to be entered in the study. In order to facilitate this process, the Kansas Data Management Unit produced a list of households having toddlers or schoolers close to the age required for CRSP enrollment based on the village census of 1,470 households. The Egypt DMU verified this list against the most recent census data available and prepared a final list of households and targets to be entered into the study.

All households, regardless of location in the village, which met the criteria of a Nutrition CRSP core family were included in the study. To qualify, a household should include at least one of the following individuals:

- adult female between 15 and 45 years of age, with mate present in household, in first trimester of pregnancy or likely to become pregnant and whose infant would be six months of age before completion of the study's second year
- child who will be 18 months of age during the study's first year
- child who will be seven to nine years of age during the study's first year

Potential targets were excluded if they were diagnosed as having a chronic disease such as diabetes, or if they were severely undernourished. Details are presented in the sections on anthropometry and morbidity.

Once a target household was selected, the following individuals also became key study subjects:

- mate of the adult female
- mated pair who are the parents of the targeted child

Ages of children were then calculated from their date of birth. If the age criteria presented above were met, the child also became either a target toddler or a target schooler.

Infants born on or before June 1, 1985 also became target subjects if their mothers, the target females, had participated in the study from their third month of pregnancy until the child's birth.

If a household found to be ineligible for any reason, such as the wrong age of the toddler or schooler, the family's departure from the village, the occurrence of a divorce, or the death of a potential target, the household was not entered in the study. This enrollment procedure continued on a monthly basis until December 1984 when the final group of households was entered. Lists of pregnant females were generated from the field via periodic pregnancy tests.

2. Individual Identification Numbers

Each study subject was assigned a unique nine-digit individual identification number. This number permits variables from all research activities to be matched or merged by subject(s) for the construction of analytical models and subsequent hypothesis testing and parameter estimation.

The individual identification number was constructed from four demographic variables:

- Block number (2 digits)
- Household number (4 digits)
- Target individual identification number (1 digit)
- Person (or household member) identification number (2 digits)

Its structure is as follows.

```
_____________________________________________________________
|     |     |     |     |     |     |     |     |     |     |
|     |     |     |     |     |     |     |     |     |     |
|_____|_____|_____|_____|_____|_____|_____|_____|_____|_____|

\_____________/ \_____________________________/ \____/ \____________/
   Block No.          Household No.              Target     Person
                                                 ID No.     ID No.
```

e.g. 010067205

01	= Block number
0067	= Household number
2	= Target individual identification number
05	= Person or household member identification number

3. Field Scheduling

Field data collection schedules for all Egypt Nutrition CRSP research activities were developed by the Kansas Data Management Unit and sent to Egypt for implementation. The following criteria were used to construct the schedules:

- age of target children (schoolers, toddlers, and especially, infants)
- frequency of data collection for target individuals and households
- concurrence of data collection for simultaneous analysis
- convenience to study participants
- convenience to study
- location of data collection site (e.g. in home or at health facility)
- availability and number of fieldworkers
- time of day requirement for collection of certain data

4. Sample Monitoring

The Egypt Data Management Unit monitored the pregnancy status of Kalama women at risk of becoming pregnant, live births, and the ages of potential target children. Households were enrolled into the study as they met study inclusion criteria.

The Egypt Data Management Unit also monitored the status of data collection and study qualification status of households and individuals in the sample. All changes in status of the core sample were recorded on specially developed "change of status" forms. Target individuals were followed for a period of one year. However, target households were followed from one to two years depending on the study status of individuals in the household. When all target individuals in a household had completed the study, or the household no longer met core household qualifications, the household was excluded from further data collection. A formal Household Exit Form would then be completed on the exiting household.

Each household with a target toddler or schooler remained with the study until 13 months of data had been collected on the target child. Households with target infants were followed for approximately six months of the mother's pregnancy, and continued until the infant was six months of age. All households were exited by the end of December, 1985.

Following is a summary of Household and Target statistics for CRSP:

a. A total of 312 households were enrolled in the study
(1) 181 households based on target toddler and/or schooler
(2) 131 households based on pregnancy (Table 4.46)

b. A total of 191 pregnant females were followed: 131 as mentioned above plus an additional 60 pregnant females from households having a target toddler or schooler

c. The first infant in CRSP was born in July 1984 and the last in May 1985.
Total number of infants was 142: 104 infants from the pregnant female group of 131 and 38 infants from households with a target toddler or schooler (Table 4.47)

d. Deaths of targets occurring during the study were as follows: 10 infants, four toddlers, and two adults

Table 4.46.
Distribution of sample households* by blocks based on eligibility of target individuals

Block No.	Total households	Households with toddler and schooler	Households with pregnants
1	35	25	10
2	27	20	7
3	42	29	13
4	14	10	4
5	11	2	9
6	21	9	12
7	28	17	11
8	33	14	19
9	20	12	8
10	20	12	8
11	32	10	22
12	19	21	8
Total	312	181	131

* Some households contributed multiple targets such as a pregnant woman and a toddler. Occasionally, a household would provide all five targets. Due to the research burden on such a household, the project did not encourage this.

Table 4.47.
Enrollment of infants in the study by month of birth and characteristic of mother

Enrollment by month		Number of Infants: From potentially pregnant	Number of Infants: From females with toddler and schooler
July	1984	6	4
August	1984	11	3
September	1984	19	6
October	1984	9	5
November	1984	8	3
December	1984	12	4
January	1985	21	4
February	1985	12	6
March	1985	3	3
April	1985	5	0
May	1985	1	0
TOTAL		104	38

e. A total 258 households completed the study with 153 toddlers, 121 schoolers and 124 infants (Table 4.48). 54 households or 17.3% of those entered were dropped from the study before completion. Table 4.48 displays the status of the sample as of March, 1985. Final data are available but have not yet been processed.

Table 4.48.
Status of households in the sample - March, 1985

Date	Household entry by reason					Household exit by reason				
	Preg.	Todd. only	Sch. only	Multi-ple	Total	With-drew*	Incom-plete†	Completed study‡	Total	Grand total
10/83	0	4	1	0	5	0	0	0	0	5
11/83	0	9	0	10	19	0	0	0	0	24
12/83	0	13	0	6	19	0	1	0	1	42
1/84	1	11	6	0	18	0	2	0	2	58
2/84	9	10	3	7	29	0	0	0	0	87
3/84	34	13	1	4	52	0	6	0	6	133
4/84	14	10	7	2	33	0	3	0	3	163
5/84	5	2	0	7	14	0	3	0	3	174
6/84	10	0	0	7	17	0	3	0	3	188
7/84	15	0	0	7	22	0	0	0	0	210
8/84	32	0	0	5	37	0	0	0	0	247
9/84	6	0	0	10	16	0	0	0	0	263
10/84	10	4	5	10	29	0	3	0	3	289
11/84	0	0	7	2	9	1	5	0	6	292
12/84						0	0	11	11	281
1/85						0	0	11	11	270
2/85						2	3	20	25	245
3/85						0	22	32	54	191

* Withdrew: An eligible respondent who withdrew from the study.

† Incomplete: Incomplete data due to death, false pregnancy, incorrect age, abortion or conflicting information on respondent status.

‡ Completed study: Household completed month 13 for toddler or schooler and/or six months for infant.

f. Missing data was examined on a sample of 53 toddlers who had completed 13 months of the study including one measurement at Month 0 and also at Month 13:
(1) Anthropometric measurements were completed at an overall rate of 60%, ranging from 36-85%
(2) Food intake ranged from 62-92% complete with on overall rate of 77%
(3) Morbidity was 78% complete, ranging from 66-90%

5. The Final Sample

The Egypt Nutrition CRSP was designed to yield 100 subjects of each of the five target types (adult male, adult female, school-age child, toddler and infant). The final tally of target individuals is as follows:

- 258 target males
- 120 target females, non-pregnant and non-lactating
- 133 target females, pregnant
- 102 target females, lactating
- 126 target schoolers
- 150 target toddlers
- 104 target infants

Documentation of the final sample shows the entry and exit dates with criteria for all target individuals and households. Details are presented in Section F.2.d. on Creating Files.

F. Data Processing and Organization

1. At the Egypt DMU

a. Data Entry

In August 1984, a data entry team (DET) was organized as the part of the Egypt DMU to be the link between all data collected by the research activities of the project and Al-Ahram Computer Center in Cairo, and ultimately between the Egypt and Kansas DMUs. The DET's role was to provide clean, checked data tapes to the Kansas DMU.

b. Data Flow Scheme

The following scheme describes the proposed steps in data flow from the Egypt DMU to the Kansas DMU.

(1) Original data from DMU ---> DET ---> Al-Ahram (enter and range check)

(2) Printout from Al-Ahram ---> DET ---> Senior Investigator with original data

(3) Corrected printout ---> DET ---> Al-Ahram (correct entering errors and 2nd range check)

(4) 2nd printout from Al-Ahram ---> DET ---> Senior Investigator: acceptance or further correction

(5) Data tape from Al-Ahram ---> DET ---> Kansas DMU

The timing of the above data flow scheme varied with the volume and type of data involved. Generally, the DET received data from the DMU weekly on Tuesday and Wednesday and forms were sent to Al-Ahram on Wednesdays. As soon as printouts of data listings and range checks were received from Al-Ahram, they were distributed to Senior Investigators accompanied by data forms for verification and review of out-of-range values. Research teams took from 2-10 days to review the printouts before sending them back to Al-Ahram. Corrections to the data were made within 1-2 days and a corrected printout was sent back to the Nutrition Institute.

The DMU was responsible for receiving reviewed and coded-for-entry data forms from each research team, and preparing them for transfer to Al-Ahram by the DET. For some data sets, photocopies of the original data forms were sent to Al-Ahram for key entry; however, the original data forms were sent for voluminous data sets (e.g. food intake, morbidity recall, and physical exam). A system was designed to document the type and number of forms in step one of the above scheme. The DMU completed a form (including the following data) before transferring any data to the DET:

Form	Schedule	Date	Block/Hh No.	Total

Data forms taken to Al-Ahram were accompanied by a DET form (illustrated below) to be signed by the person at the computer center who received the data. Information categories on the DET form follow:

Form Number	Schedule Number	Date Included	Number Forms	Total

This form was completed in triplicate with copies to the person receiving the data at Al-Ahram, the data entry clerk, and the DET.

c. Organization Linking the Nutrition Institute and Al-Ahram

A data team consisting of the data entry group supervisor and two persons responsible for data organization and programming was organized at Al-Ahram. The Al-Ahram team met each week with the supervisor of the Nutrition Institute DET to discuss data processing problems. Some of the topics discussed were:

(1) priorities for data entry
(2) timetables for receiving and returning printouts
(3) timetables for receiving tapes
(4) scheduling meetings between the Nutrition Institute and Al-Ahram personnel
(5) range checks

Periodically, other meetings between CRSP Principal Investigators or Senior Investigators and the Director of Al-Ahram Computer Center or the data entry group were scheduled.

d. Data Entry Priorities and Procedures

Priorities for data entry were based on the availability of data sets from each research team and on SCB priorities.

Beginning in January, 1985, a double entry system was implemented for all data. As a result, errors decreased from approximately 10% to 2%.

Procedures for data entry included (a) developing a key for each data collection form to identify the data and the column numbers for key entry and (b) discussing the keys with Al-Ahram's data team before data entry began. The first 28 columns on all forms were standardized to enable future data analyses between data sets.

Each research activity had a unique form identification number and a unique schedule number to identify each of its data collection instruments, e.g. the reproduction/lactation form - Lactation and Infant Feeding - was coded and Form 2, Schedule 7.

Range checking was performed on all data before the first printout left Al-Ahram.

The final step in the data entry system involved ordering a data tape for transfer to the Kansas DMU. Ideally, four to six days before a data tape was scheduled for transfer, Al-Ahram was instructed on data transfer needs, i.e. type of data needed and inclusive dates to be put out on tape. The following documentation information accompanied each tape:

(1) tape number
(2) form and schedule numbers
(3) dates included
(4) sorting method
(5) checking method
(6) type of data
(7) number of records

(8) date received from Al-Ahram
(9) date and method of sending to Kansas DMU

2. Kansas Data Management Unit

The Kansas DMU assumed responsibilities for entering and processing all project data from the beginning of the study in 1982 through July 1984. The Kansas DMU continued data entry activities on child caregiving and time allocation data through October, 1987.

a. Logging In Data

When data arrived at the Kansas DMU each form was stamped with the date received. Data were then sorted by type of data collection instrument, block number, household number, date of collection and time of collection (if applicable). Number of forms received by type of form and date of collection were recorded for future reference.

b. Preparing Data for Computer Entry

Before data were entered, forms were sight-checked by the Data Entry Clerk. Missing information, questionable values, and illegible data were recorded and described on the "Data Resolution Form from Kansas DMU" (Appendix A). This form was printed in triplicate. Copy 1 was photocopied and sent to the Egypt Project Field Coordinator and Egypt DMU for resolving problems. The Egypt DMU returned Copy 3 to the Kansas DMU, documenting the resolution of the problem.

Data collection instruments (already sorted by type, block number, household number, and date of collection) coding sheets were entered onto the computer in order of the date they were received.

c. Entering and Verifying Data

All data were computer entered twice, each time by a different person. Both sets of data were they run through a "compare program". The printout was checked and verified by the Data Entry Clerk. Discrepancies between the two sets were resolved by returning to the original data and entering the correct value.

d. Creating Files

After data were entered onto the computer, they were organized into raw data files and transferred to tape. Data entered in Egypt were prepared to this stage and sent on tape to the Kansas DMU for further processing. Separate files were created for the following areas of research:

- Household entry
- Household change and exit
- Mortality notification and diagnosis
- Household demography
- Household demography update
- Household socioeconomics
- Household socioeconomics update
- Household food use summary
- Individual food intake summary
- Supplementary feeding (infant)
- Anthropometry
- Resting metabolic rate
- Clinical exam
- Immunology

- Reproduction and lactation
- Household morbidity
- Special illness subroutine
- Treatment for illness
- Sanitation and hygiene
- Child caregiving
- Psychological function
- Time allocation
- Community socioeconomics and weather

Logic and validity checks were applied to each data set at this stage. Raw data files were then assembled into SAS data sets. Each SAS data set contained all the required core Nutrition CRSP variables for its research area. Project investigators were responsible for mapping variables from the survey instruments to the SAS data set.

G. Quality Control Procedures

1. At the Egypt DMU

Supervisors checked all measurements recorded by fieldworkers for omissions, coding errors, and inconsistencies. These were corrected. Data entered directly onto the computer were verified.

2. At the Kansas DMU

In order to achieve 100% verification, all data were entered twice and compared for discrepancies. In addition, range checks and frequency distributions were performed to plot trends over time. University checks were also performed on new data. Discrepancies and missing data were referred to the Principal Investigators for resolution.

H. Distribution of Data Tapes and Hard Copies to Investigators

Data tapes and hard copies were routinely distributed to the project statisticians, four project Principal Investigators, and the Management Entity. The transfer of tapes, organized into SAS files, and hard copies followed a predetermined schedule early in the project. However, schedules were later modified to accommodate the lag in data flow from Egypt.

Tapes, organized into SAS files, were transferred simultaneously to the statistician at Purdue University and to the Management Entity at the University of California Berkeley.

APPENDIX A

DATA RESOLUTION FORM FROM KANSAS DMU

INVESTIGATORS U.S. _____

EGYPT _____

DATE TRANSMITTED TO EGYPT

DAY ☐☐ MONTH ☐☐ YEAR ☐☐

FORM OR INSTRUMENT	I.D. NOS. AND DATA COLLECTION DATE	ISSUE TO BE RESOLVED	EGYPT DMU RESPONSE/ACTION
	BLOCK ☐☐ HHNO ☐☐☐☐ INDIVIDUAL I.D. ☐☐☐ DATE OF COLLECTION ☐☐ DAY ☐☐ MONTH ☐☐ YEAR	☐ QUESTIONABLE VALUES ☐ MISSING VALUES ☐ LEGIBILITY DESCRIPTION _____	DESCRIBE _____ DATE RESOLVED ☐☐ DAY ☐☐ MONTH ☐☐ YEAR
	BLOCK ☐☐ HHNO ☐☐☐☐ INDIVIDUAL I.D. ☐☐☐ DATE OF COLLECTION ☐☐ DAY ☐☐ MONTH ☐☐ YEAR	☐ QUESTIONABLE VALUES ☐ MISSING VALUES ☐ LEGIBILITY DESCRIPTION _____	DESCRIBE _____ DATE RESOLVED ☐☐ DAY ☐☐ MONTH ☐☐ YEAR
	BLOCK ☐☐ HHNO ☐☐☐☐ INDIVIDUAL I.D. ☐☐☐ DATE OF COLLECTION ☐☐ DAY ☐☐ MONTH ☐☐ YEAR	☐ QUESTIONABLE VALUES ☐ MISSING VALUES ☐ LEGIBILITY DESCRIPTION _____	DESCRIBE _____ DATE RESOLVED ☐☐ DAY ☐☐ MONTH ☐☐ YEAR
	BLOCK ☐☐ HHNO ☐☐☐☐ INDIVIDUAL I.D. ☐☐☐ DATE OF COLLECTION ☐☐ DAY ☐☐ MONTH ☐☐ YEAR	☐ QUESTIONABLE VALUES ☐ MISSING VALUES ☐ LEGIBILITY DESCRIPTION _____	DESCRIBE _____ DATE RESOLVED ☐☐ DAY ☐☐ MONTH ☐☐ YEAR
	BLOCK ☐☐ HHNO ☐☐☐☐ INDIVIDUAL I.D. ☐☐☐ DATE OF COLLECTION ☐☐ DAY ☐☐ MONTH ☐☐ YEAR	☐ QUESTIONABLE VALUES ☐ MISSING VALUES ☐ LEGIBILITY DESCRIPTION _____	DESCRIBE _____ DATE RESOLVED ☐☐ DAY ☐☐ MONTH ☐☐ YEAR

INSTRUCTIONS

COPY 1 - KANSAS DMU & INVESTIGATORS COPY 2 - EGYPT COORDINATOR & DMU COPY 3 - KANSAS DMU

XII. STATISTICS METHODOLOGY

A. Overview

Analytical models were developed to provide the framework for asking and answering the major research questions of the CRSP. The models specify the general form of the relationships among the different variables measured and contain parameters to be estimated by the data. The parameter estimates along with their associated standard errors and significance tests can be used to answer the research questions.

The major statistical effort in the Egypt project commenced in July 1985 with the addition of George McCabe and Linda McCabe to the project staff. Since that time, valuable statistics and programming support has been provided by several individuals during various periods of time. Among these are Sara Fisher, Eric Fox, Jon Powell, Regina Becker, Julie Keller, and Laurie Streeter. Their assistance has been essential to the progress of the analytical effort.

Almost all of the statistical computing for this project has been done using the SAS software package. The capabilities of this package for processing raw data files to produce analytical data files are truly remarkable. Furthermore, the power of the package for statistical analysis of the complex models developed to analyze the data is noteworthy.

B. The Process

The major research questions addressed by the CRSP are broad and can easily be stated in general terms. How does food intake relate to various functions? Translating the questions into statistical models is neither straightforward nor trivial.

It is clear that the nature of the important functions is complex. It is not particularly surprising, therefore, that the nature of the needed statistical models is also complex. Dealing with this situation has required a great deal of cooperation and interaction between those with expertise in the substantive areas and the statisticians. The education of the statisticians on various matters pertaining to nutrition, anthropometry, morbidity, psychology, and other areas has been an essential component in the analytical process. Similarly, no meaningful progress on the analytical models could have taken place without the active involvement of the researchers in this process.

The philosophy underlying the model building and analysis is that the simplest framework, which is at the same time correct and defensible, is to be preferred. Unfortunately, in the present context, the procedures found in elementary statistics texts do not provide sufficient depth to explore the relevant research questions properly. This statement is not made in the abstract but rather is a conclusion drawn from the experience of two years spent in intimate contact with the data from this project.

The results of some of the analyses presented elsewhere in this report would not have been obtained with the computing power available a few years ago. This is one reason why textbook solutions are not available. On the other hand, the abstract theoretical framework for the analyses does exist and is commonly taught in statistics graduate programs. An important scientific accomplishment of this project, from a statistical point of view, is the successful translation of the abstract theory into models which can be analyzed using available statistical software and which address important substantive questions.

In evaluating the analytical progress that has been made to date, two important points should be considered. First, each measured variable must be examined and understood in detail before meaningful relationships can be assessed. Second, this examination requires final versions of the data sets which have not been available until recently.

Some comments regarding the data files are given in the next section. For those who may undertake analyses of these data in the future, this difficulty will not be present. However, the first point is more fundamental and deserves further comment. It is fully operational, even while this report is being written.

It is important to note that the difficulty in responding to pressure to produce major results is not unique to this project. Any effort to understand a large and complex data set is beset with this sort of problem.

There is no easy resolution. From the viewpoint of the statistician, it is necessary first to fully understand each of the variables measured. The idea sounds trivial but its implementation in practice can be exceedingly difficult. Understanding not only involves grasping the basic substantive idea behind the measurement but also includes a fair bit of statistical analysis.

An example may help to illustrate the point. How does food intake relate to growth of the toddler? It is easy to take the data for each toddler, generate an average food intake and an average weight. These can be correlated. This sort of exercise has been done and is useful descriptively. However, it is of very limited help in addressing the basic research questions of the CRSP.

If we look carefully at toddler weights we see, not surprisingly, that they are changing with age. Furthermore, not all toddlers have data taken at the same times. Therefore, an average for one toddler will be taken over different ages than that for another. The problem is not easily dismissed with the statement that everything will average out. To discuss weight we need to first understand the nature of its relationship with age and examine it in the context of a model which takes this into account.

Food intake is even more complex. For example, many toddlers are breast-fed, particularly between the ages of 18 and 22 months. An analysis of food intake that does not account for this fact is incomplete.

C. The Data

For the Egypt project the data management and statistics activities were carried out by separate staffs at the University of Kansas and Purdue, respectively. Details regarding the data management activities are presented elsewhere in this report. The comments in this section pertain to the aspects of the data which impact on the statistical model development and the analysis of these models.

The most remarkable characteristic of the data is its sheer volume. To date we have been sent 22 computer tapes. The tapes contained 125 files. The total number of pieces of information is about 24,000,000. Most of the files received were updated and corrected versions of other files. Final versions of the food intake, morbidity, and anthropometry files were received at Purdue in April, May, and June of 1987, respectively.

Many attempts were made to clean the data files at various levels. This activity took place in Egypt, Kansas, Arizona, and Purdue. At the present time there still remain problems with some of the files. Anyone attempting to use the files should be aware of these problems and take appropriate action.

Some files still contain more than one record for the same ID (a unique identifier for each individual) and date. At the analysis stage we dealt with this problem as follows. If an item was present in only one of the records, then that information was used. Where the information was present in more than one record, the item from the last record was used.

Some variables have values which are clearly in error. Statisticians call such values outliers. At various stages in the analytic process, algorithms were suggested for deleting such cases. A great deal of effort was spent on this task with the statisticians from all three projects cooperating. Many of the algorithms proposed did not work in practice. The present resolution of the problem is to take a rather conservative approach. Only values which are clearly extreme and obvious errors have been eliminated when performing analyses. Decisions regarding these eliminations have been made in consultation with the PI's. Because of the conservative nature of the rules, only an exceedingly small number of observations have been eliminated.

The situation is perhaps best illustrated by an example. Consider food intake in kcal. We have a value of about 60,000 and another of about 6,000. When this example was discussed with an eminent theoretician in the Purdue Statistics

Department who does not 'believe' in outliers, he stated that the 60,000 clearly appeared to be an error. However, he would welcome the challenge of eating 6,000 kcal in a day, especially if he were allowed to choose the food items. Our resolution has been to exclude the 60,000 but to keep the 6,000.

D. Descriptive Statistics

The purpose of the descriptive statistics is to summarize the basic characteristics of the data. This is a necessary first step in any data analysis strategy. The descriptions point the way to further analyses and uncover potential difficulties that need to be considered in the subsequent steps.

For many variables, the situation is relatively straightforward. Socioeconomic status is an example. A table is easily constructed giving the percentage of toddler households falling into each of the four categories. This summary assumes that the measure is stable over time, or if it is not, that the measure was taken for all toddlers at an equally relevant time. Judgments regarding these assumptions are outside the realm of statistics.

The protocol called for many measures to be taken monthly or according to some other regular schedule. As an example, consider the toddlers. Monthly measurements on anthropometry and food intake are part of the design. Thus, we have a measurement for age 18 months, 19 months, ..., 30 months.

Or do we? Note that the above span covers a year (12 months) but there are 13 numbers between 18 and 30, inclusive. The first problem is to define a month for age. To do this we need birth dates. Obtaining this information was a very difficult task. It should be realized that birth date, like any of the other measures, may have some noise or error present.

Given that we have a birth date, we define monthly 'windows' by constructing cut points in time at 30-day intervals. This gives 12 windows for the year. At the beginning and end we add an extra two weeks to the window to utilize data that might be just outside of the beginning and end dates. Within each window we average all data and produce files with the structure of toddler ID by age in months.

The file is then processed to produce monthly means, standard deviations and whatever other descriptive measures are desired. One noteworthy characteristic of this type of summary is the varying sample size across months. With different individuals in different months, the descriptive value of the month by month comparison is impaired. Summaries broken down by sex and breast-feeding status illustrate this phenomenon even more dramatically.

Detailed examination of the process by which data values were assigned to months reveals that it is not uncommon to find two observations within the same window with none in the following or preceeding window. This situation is partly due to the somewhat arbitrary definition of the windows. Another cause is the fact that the field protocol is more complicated than our 30-day window approximation.

To deal with the above reality, we have used the idea of a 'fuzzy window'. If in any given window there are no observations, then the previous window is examined. If this window has more than one observation and an observation is within seven days of the cut point, the observation is moved to the empty window. The process is then repeated looking forward rather than back. Most of the tables presented in this report use this approach. In some cases the total amount of data available for summary increased by about 20 percent.

One of the most important variables in this study is food intake. For many purposes it is desired to express this in kcal per kg of body weight. A problem arises in matching the kcal to the kg for the division when, in general, these two variables are not measured on the same day.

One solution is to use the fuzzy windows. This is a reasonable procedure, despite the fact that the two measures in the ratio may be taken rather far apart in time.

An alternative approach was used with the toddlers and could be adapted for other target groups. The first step is to develop a model for weight. This is relatively easy for the toddlers; within the 18 to 30 month age period, growth is essentially linear. This fact is suggested by the growth curves available in the literature and has been verified in the data used in these analysis.

For each toddler a linear regression of weight on age is run. Toddlers for whom the dates of weight measurements do not span at least 180 days are excluded. The resulting regression coefficients can then be used to determine estimated or predicted weight for any given day, in particular for days on which the food intake variable is measured. The ratio of kcal to estimated weight has been used in most of the toddler analyses. This approach has been compared with several alternatives and no noticeable difference is evident. An advantage of this approach is that it increases substantially the number of kcal measurements that can be converted to kcal/kg.

E. Statistical Models

A variety of statistical models and methods were used to analyze the data. In addition to the standard elementary procedures, a collection of more complex approaches were employed.

As mentioned above, simple linear regressions were used frequently. Multiple regressions were used in several places. When the numbers of variables were large, an all-possible subsets routine (PROC RSQUARE in SAS) was used to select variables.

Many of the important analyses are based on what statisticians call the general linear model. This framework includes simple and multiple regression, analysis of variance, analysis of covariance, and even lag and autoregression models. Many of the models used to draw conclusions in this report are based on a mixture of these techniques run with SAS PROC GLM.

Since the details of these models are complex and in many ways are results rather than methodology, further explanations are given in the statistics section of the results part of this report.

F. Food Intake Data

1. Collection of Food Intake Data On Days With Illness

A question has been raised regarding the possibility that food intake measurements were more or less likely to be taken when illnesses were present. This question is examined in detail for toddlers. The set of potential observation days is defined to be the interval of time between the day each toddler was 18 months of age and 360 days later plus fourteen days on either side to give a total of 384 days.

For food intake each day was classified as YES or NO, depending upon whether or not a food intake record is in the data set. The classification for morbidity is a little more complicated. There are three classifications. If the toddler was sick on the day, it is classified as a YES for sick. If there is no record of illness and the day is covered within the range of a recall record, the day is classified as a NO for sick. If neither applies, the day is classified as DON'T KNOW.

There is an obvious relation between FOOD and SICK when the DON'T KNOW category is taken into account. The food measurement is much less likely to be present on such days as are all other measures. These days are excluded from further consideration.

The following gives the pattern of days for FOOD and SICK:

		SICK	
		NO	YES
FOOD	NO	34980	4496
	YES	1742	231

Overall, food data was collected on 4.76% of the days; it was collected on 4.74% of the well days and 4.89% of the sick days. The chi-square statistic calculated from this table is 0.189, which is nowhere near statistically significant.

The above calculation is straightforward but it rests on a faulty model. The fact that subsets of observations in the table come from different toddlers should be taken into account. This scenario illustrates a general concern which must be taken into account with many of the CRSP data sets.

In attempting to account for toddler effects, it is convenient to think of a collection of 144 tables similar to that given above, one for each toddler contributing data to this analysis. The question is then whether or not there is an association between FOOD and SICK given toddler.

There are at least two possible approaches. One is to use log-linear models and the other is to use weighted least squares on the log-odds. In the log-linear framework the question is stated in a form very similar to that given above. For the log-odds approach, a linear model is constructed for the quantity log(p/(1-p)) where p is the probability that a food intake value is taken. Both of these procedures were run with SAS PROC CATMOD.

Unfortunately, there is a techincal difficulty due to zero counts in some of the cells. Not surprisingly, there are instances where a given toddler has no food intake measurements on days while sick. Note that overall, food intake is recorded 4.76% of the time and sickness occurs 11.4% of the time according to the above aggregated table.

The standard statistical fix for this problem is to add 0.5 to each cell with a zero count. This produces a significant result which is due to the bias in the table produced by the 0.5 additions, rather than the original data.

The problem has been examined in detail and the conclusion that SICK and FOOD are unrelated can be substantiated by appropriate modifications. The details are complicated and will not be discussed further here.

2. Comparison of Kcal on Sick and Well Days

An analysis was performed to investigate the possibility that kcal values differed markedly on sick and well days. For each toddler the average kcal for sick and for well days was calculated.

A categorical variable C was used as an indicator of sick versus well and the following model was run: KCAL = SEX ID(SEX) C SEX*C. The effects of C and SEX*C were not significant. The LSMEANS were 1094 KCAL for well days and 1132 for sick days. See below for comments on LSMEANS.

3. Other Effects

In the models below the effects of sex, age, time of year, and breast-feeding status on food intake are examined. There are other effects that have not yet been taken into account.

Some preliminary analyses have suggested that the food intake values are influenced by day of the week, the occurrence of special feast days, and Ramadan. An effect due to the interviewer who collected the food intake data also appears to be relevant. For the lead males, there are missing meals. Some preliminary models have been developed which account for these effects.

Some speculative comments on the consequences of not including such effects in the models can be made. There are basically two types of impact. First, neglected sources of variation will generally increase the residual error estimate. Inflated standard errors and decreased power for the statistical tests are the result. Regarding testing, this means that we may miss other effects that we should be able to see. We will not see things that are not really there.

The second type of impact is more involved. To the extent that the neglected effects are confounded with the effects of interest, bias may result. This is the idea behind the analysis given above regarding food intake and morbidity.

For effects that are reasonably well distributed over individuals, no bias in the results should occur. The only important effect would be increased standard errors. Given the design, this is likely to be approximately the case for the day of the week effects.

Effects such as interviewer variation are confounded with households. Since ID is included in most of the models, this sort of effect is basically accounted for in these models. Thus, most of the results regarding relationships among different variables are unlikely to be affected. On the other hand, estimates for individuals may be biased. Similarly, variables measured by the same interviewer, such as mother's and toddler's food intake, may have inflated correlations.

G. Multiple Regression

Some comments on the use of multiple regressions in the analysis of the infant data are given in the results section on infants. Some additional clarifications are offered here.

In the analysis of the CRSP data, we used multiple regression as a model building tool. This is quite different from what most users of statistics think of when they 'do a multiple regression' on a set of data. In the model building process, many models are run. An underlying structure of the data is sought using not only the numerical calculations output by the statistical software but also using a knowledge of the meaning of the variables used. Obviously interaction between the statisticians and persons knowing about the variables is necessary.

Various types of step procedures (step-wise, step-up, step-down) are widely available in statistical software packages. These procedures represent old technology. New algorithms have been developed to do optimally what the persons who developed the step procedures were trying to do when they developed these procedures. For even moderately large problems it is now possible to examine essentially all subsets of variables and to generate lists of subsets ordered by R^2 within subset size. The current power of computers and statistical software has transformed these algorithms from theoretically interesting results that might be tried on a very important data set to procedures that can be executed by one line of SAS code.

With the new methods, the user is presented with collections of models which give essentially similar results with respect to predictive power. The analyses of the infant birth weight and weight at six months illustrate this point well. Interpreting the results is a much greater task than if one were presented with just one model. Various methods have been developed to choose among models. The CP criterion is one such method and is described in any modern text on regression. These kinds of methods serve to focus the attention of the researcher on models which are potentially interesting.

H. General Linear Models

1. General Comments

The general linear model is a very flexible framework which includes simple and multiple regression, analysis of variance, analysis of covariance, and even lag and autoregression models. As implemented in SAS PROC GLM, it has been used extensively in the analyses of data presented in this report.

The mathematical form of the model is expressed as $Y=XB+E$, where Y is a vector of responses (such as toddler weights), X is a design matrix giving information about the variables to be used to explain Y (such as sex, toddler ID, age, time

of year, breast-feeding status, percentage of days sick with diarrhea, etc.), B is a vector of unknown parameters to be estimated from the data, and E expresses the error or unexplained variation. Note that the explanatory variables may be categorical, such as sex, or continuous such as percentage of days sick. They may also be lagged, such as kcal of food intake in the previous month.

To provide maximum flexibility in the most general setting, SAS uses an overparameterized version of the model. This leads to matrices with less-than-full rank, generalized inverses, estimability questions and other considerations which are beyond the scope of the present discussion. However, it is important to note that the appropriate use of these models requires some understanding of these concepts.

2. Model Building

As noted in the section above on multiple regression, the approach to the analysis of the CRSP data has been model building rather than simply running an analysis. This process is not one in which forward progress occurs at each step. The net movement is generally forward but there are many paths which do not lead anywhere. Rather than continue with abstract generalizations, a concrete example will be used to illustrate the process. Limitations of space and memory prevent the discussion of all steps. Only some highlights will be given.

How does food intake (kcal) relate to toddler weight (Wt)? To understand the **question** we must first seek some understanding of the two variables under consideration. This understanding may have some value of its own, in addition to its role in answering the above question.

We start with WT. The fuzzy window idea mentioned in the methods section is used to generate monthly weights for each toddler for 18 to 29 months of age. Means and standard deviations are calculated for each month. A general increasing pattern with age is noted and the standard deviations do not differ markedly. A troubling observation is that the sample sizes differ from month to month. If we used only cases with all 12 months present, we would have too little data to see anything meaningful.

However, a proper statistical comparison of average weights for any set of ages must take into account the fact that information from a given toddler is present in many of the monthly means. This fact is one of the strengths of the CRSP data as opposed to a cross-sectional study.

Recognizing the incompleteness of the data, we start with analysis of variance methods which can account for missing cells, or in more technical language, non-orthogonal designs. The toddlers are designated by a categorical variable which we call ID. Actually, PROC GLM generates 147 variables for the 147 toddlers used in this initial analysis. In a similar fashion we use categorical variables for SEX and time of year (TOY), which has the values 1 to 12 and represents months January to December. Age is represented by a variable M with 12 levels. An analysis of variance using SEX, ID(SEX), M, TOY and all interactions among SEX M AND TOY is run.

Using the TYPE I sums of squares which take into account the order in which terms are added to the model, we find strong effects due to SEX, ID(SEX), M AND TOY. None of the interactions contribute anything to the model.

At this point, a comment on the use of p-values and tests of statistical significance in the present context is appropriate. This framework comes from a setting in which there is a clear model and a particular hypothesis in mind. In the present example it is clearly overkill to test the hypothesis that toddler weights differ by age and report this as a conclusion. We do, however, use the F statistics as a guide in the model building process. They provide valuable information regarding terms which can be discarded when we proceed to the next step in the model building process. For the analysis of variance model above, all of the terms mentioned as contributing have p-values less than 0.0001, while those discarded range from .42 to .94.

The next step is to try to get a better model for the terms M and TOY. Preliminary plots and background information indicate that the pattern over age is essentially linear. Therefore, a linear term, MONTH, is put into the model and the

term M is added after it to check for deviations from linearity. Modelling TOY is a bit more difficult. The pattern obviously cannot be linear - month 1 (January) is adjacent to month 12 (December). By using the trigonometric functions sine and cosine two new variables, S1 and C1 are constructed to model the seasonal variation. These are entered into the model before TOY which is used to check for deviations from the fitted pattern.

Various interactions are included as checks on the previous results. The analysis indicates that SEX, ID(SEX), MONTH, S1 AND C1 fit the data well. All of these have p-values less than .0001 and there is no evident lack of fit. A total of 892 cases are used and the R^2 is .88.

Although M in the first analysis and MONTH in the second are both clearly significant, a comparison of the two is instructive and important to keep in mind in doing this sort of analysis. The factor M has 11 degrees of freedon and an F of 113.53, while the variable MONTH has 1 degree of freedom and an F of 1270.30. The test associated with M is based on an alternative which includes any sort of pattern of differences in weights over months. Most of these would not make any sense in the present context. A statistical consequence of this situation is that the test is not very powerful.

With the linear term MONTH, however, the effect is modelled as a straight line and the hypothesis of no differences is translated into a hypothesis that the slope is zero. Since the sums of squares for the two terms are about equal, the F for MONTH is about 11 times that for M. The tests for lack of fit are insurance against missing any non-linearities.

3. LSMEANS and Parameter Estimates

The general linear model framework provides the capability for estimating various quantities which provide the information needed to interpret the results. Two types of estimates are important. Each of these is accompanied by estimated standard errors.

For a variable, such as MONTH, which is commonly called a continuous variable, the parameter estimate is a slope, and is very much like that obtained in a regression analysis. For models containing an interaction of a continuous variable with a categorical variable, an estimate of a slope for each level of the categorical variable is needed. These estimates are not automatically produced by the procedure and must be requested by the ESTIMATE option.

For a categorical variable, such as M, TOY or SEX, we obtain something called LSMEANS. These are linear combinations of the estimated parameters of the model which estimate the mean for each level of the category in a situation where all values of other variables in the model are set to their average value. Thus, for example, the LSMEANS for TOY in the above model give an estimated weight for each month of the year averaged over sexes, toddlers and ages.

The average is not an average in the usual sense where a collection of numbers is summed and divided by the size of the collection. Rather it is a theoretical construct in the context of the fitted model. If the design was such that there were equal numbers of observations in each cell and no missing values, the LSMEAN would be equal to the ordinary mean. It is attempting to estimate the value that would have been obtained had there been no missing values.

Both parameter estimates and LSMEANS are given with estimated standard errors. In general the standard errors for LSMEANS will be less that the ordinary means obtained initially for descriptive purposes. The LSMEANS generally appear to be smoother when viewed across ages.

4. Models for Toddler Anthropometry

In this section, models developed for weight, height and weight for height using both raw scores and z-scores are presented. Initially percentile scores and percentage of median were also analyzed. The percentile scores suffer from serious distributional difficulties with clear skewness to the right being evident (scores are clustered in the low percentile range). The standard statistical transformations for dealing with this situation were applied and were found to be

essentially equivalent to the z-scores. Although the percentage of median variable was not examined extensively, it is expected that the results would be very similar to those obtained for the z-scores.
The variable definitions are as follows:

(a) SEX - a categorical variable;
(b) ID OR ID(SEX) - a categorical variable for individuals, may be nested within sex;
(c) M - a categorical variable for age in months, coded 1 to 12;
(d) MONTH - the continuous version of M, values are 1 to 12;
(e) TOY - a categorical variable for time of year in months, values are 1 to 12, corresponding to January to December;
(f) 1 and C1 - continuous versions of TOY, more precisely, S1=SIN(2*PI*TOY/12) and C1=COS(2*PI*TOY/12);

In each case, a purely categorical (analysis of variance) model is presented. When this could be simplified using continuous variables, a second model is given. Terms of the form A*B represent interactions. Note that each individual can contribute up to 12 cases for these analyses. N is the total number of cases.

WEIGHT (N=892)
WEIGHT= SEX ID(SEX) M TOY; R^2=.89.
WEIGHT= SEX ID(SEX) MONTH S1 C1; R^2=.88.

WEIGHTZ (N=892)
WEIGHTZ= ID M TOY; R^2=.85,
WEIGHTZ= ID MONTH S1 C1; R^2=.84.

LENGTH (N=847)
LENGTH= SEX ID(SEX) M M*SEX TOY; R^2=.92.
LENGTH= SEX ID(SEX) MONTH MONTH*SEX S1 C1; R^2=.92.

LENGTHZ (N=847)
LENGTHZ= SEX ID(SEX) M M*SEX TOY; R^2=.89.

WEIGHT/LENGTH (N=824)
WEIGHT/LENGTH= SEX ID(SEX) M TOY; R^2=.81.

With the exception of SEX in the model for LENGTHZ, all terms included in the above models are statistically significant, most with p-values of .0001 or less. The exception was included because of a significant M by SEX interaction.

5. Models for Toddler Morbidity

Models were developed for four morbidity measures. The basic structure of observations by month and the variable names are the same as given above. The predicted variables are all percentages of days sick for various categories of illness. These were constructed as follows: a day counts in the numerator if there is an illness episode of the given type on that day; a day counts in the denominator if it is counted in the numerator or if there is an illness recall record covering the day. The last qualification is needed because there are days with a recorded illness but no recall coverage.

The following models were obtained:

PSICK (all illnesses) (N=1623, the total number of cases)
PSICK= ID TOY M; R^2=.25.

PSICKNOS (all illnesses except skin) (N=1623)
PSICK= ID TOY M; R^2=.26.

PDIAR (diarrhea) (N=1623)
PDIAR= ID TOY M; R^2=.25.

PRES (respiratory) (N=1623)
PRES= ID TOY M; R^2=.21.

Note that the R^2 values are considerable lower than those obtained for the anthropometry measures. Although terms like MONTH, S1 and C1 explained some of the variation, lack of fit was indicated and hence the models are presented in the above form.

This means that the age and seasonal effects are too complex to be modelled with these simple functions. One problem may be the influence of unusual cases in the analysis. Since the distributions of these morbidity measures are markedly skewed, transformations may be helpful. Further work is needed to refine these models.

6. Models for Toddler Food Intake

Two measures of food intake were modelled: daily food intake expressed in kilocalories (kcal) and this measure divided by weight (kcal/kg). The weight used was the estimated weight from the individual toddler regressions of weight on age.

Food energy is defined as 9 times fat plus 4 times the sum of protein and carbohydrate. The variable kcal is obtained from this measure by using a proportional adjustment for both interviewer and day of the week effects.

Since a large number of toddlers were breast fed during the course of this study, an additional variable carrying this information was used in developing these models:
BF - a categorical variable indicating whether or not the toddler was breast fed during any given month. Weaning dates, rather than information from the food intake records, were used for this calculation.

KCAL (N=1222, the total number of cases)
KCAL= ID BF M; R^2=.34.

KCAL/KG (N=1036)
KCAL/KG=ID BF M TOY BF*TOY: R^2=.35.

Since very few toddlers were not weaned by 24 months, additional runs were made for ages 18 to 23 months to further explore the effects of breast feeding and its interaction with age. For both of the above variables, the models found were ID BF M.

7. Models for Infant Weight

Several models were developed for the weight of infants from birth to six months. There appears to be a rather small sex effect. The growth curve is not linear but is reasonably well approximated as a linear function of (age)•55. This value was graphically determined using LSMEANS. There is still statistically significant lack of fit, which is most likely due to trying to include the birth weight in the model. A plot of the fitted growth curve WT=2703+242*(AGE)•55 with the LSMEANS is given in Figure 4.1. Standard errors for the intercept and slope are 40 and 3.4, respectively.

A time of year effect (TOY) is evident, most of which is captured by S1 and C1. The deviations from the above model with the TOY LSMEANS and the fit using S1 and C1 are plotted in Figure 4.2.

It can be seen that the average weights for infants are about 200 grams high in May and 200 grams low in October, relative to that which is predicted using age.

8. A Model for Weight of Women during Pregnancy and Lactation

The characteristics of weight changes during pregnancy and lactation are considerably more complicated than the growth patterns for toddlers and infants. Nonetheless, the same general approach works. The characteristics of the model agree qualitatively with the analyses presented in the results section on reproduction. The model estimates a linear gain in weight from about 200 days before birth to the day of birth. This slope is 0.04 kg per day (se=0.002). Then, there is a drop in weight of 5.9 kg (se=0.32). Post-partum to day 200, there is a linear weight loss at the rate of .002 kg per day (se=0.002). The latter is statistically indistinguishable from zero. The weight at 200 days before birth is estimated to be 60.8 kg (se=0.23).

Thus the model contains four parameters for the weight changes over time. The R^2 is .95 and there is no significant lack of fit. The resulting fit and much of the idea behind the model development are illustrated in Figure 4.3. The descriptive means are represented by the six stars and the LSMEANS by the circles. The fitted model is superimposed.

I. Relating Food Intake To Function

The above models provide a framework for investigating the relationships between food intake and the functions modelled. The basic idea is to use the information from the function model and the food intake model as the starting point for construction of a combined model relating the two.

Results of this approach for toddler weight are discussed in the results section for toddlers.

Some earlier attempts at modelling used autoregression ideas. Lagged weight (weight the previous month), for example, was included in the weight model. At the present stage of development, only lagged kcal is being used in the models.

Further work on these models is obviously needed.

J. Graphical Displays

Figures 4.1, 4.2 and 4.3 present graphs which are designed to illustrate important features of the models and the model building process. It is hoped that these plots facilitate the basic understanding of the data and analyses.

A map of Kalama is given in Figure 4.4. Using the toddlers as a base, average sanitation-hygiene scores were computed for each block. See Chapter 4 Section V for details. An analysis of variance indicated that there were differences in blocks. The geographical variation in these scores is illustrated in the graph by differential shading.

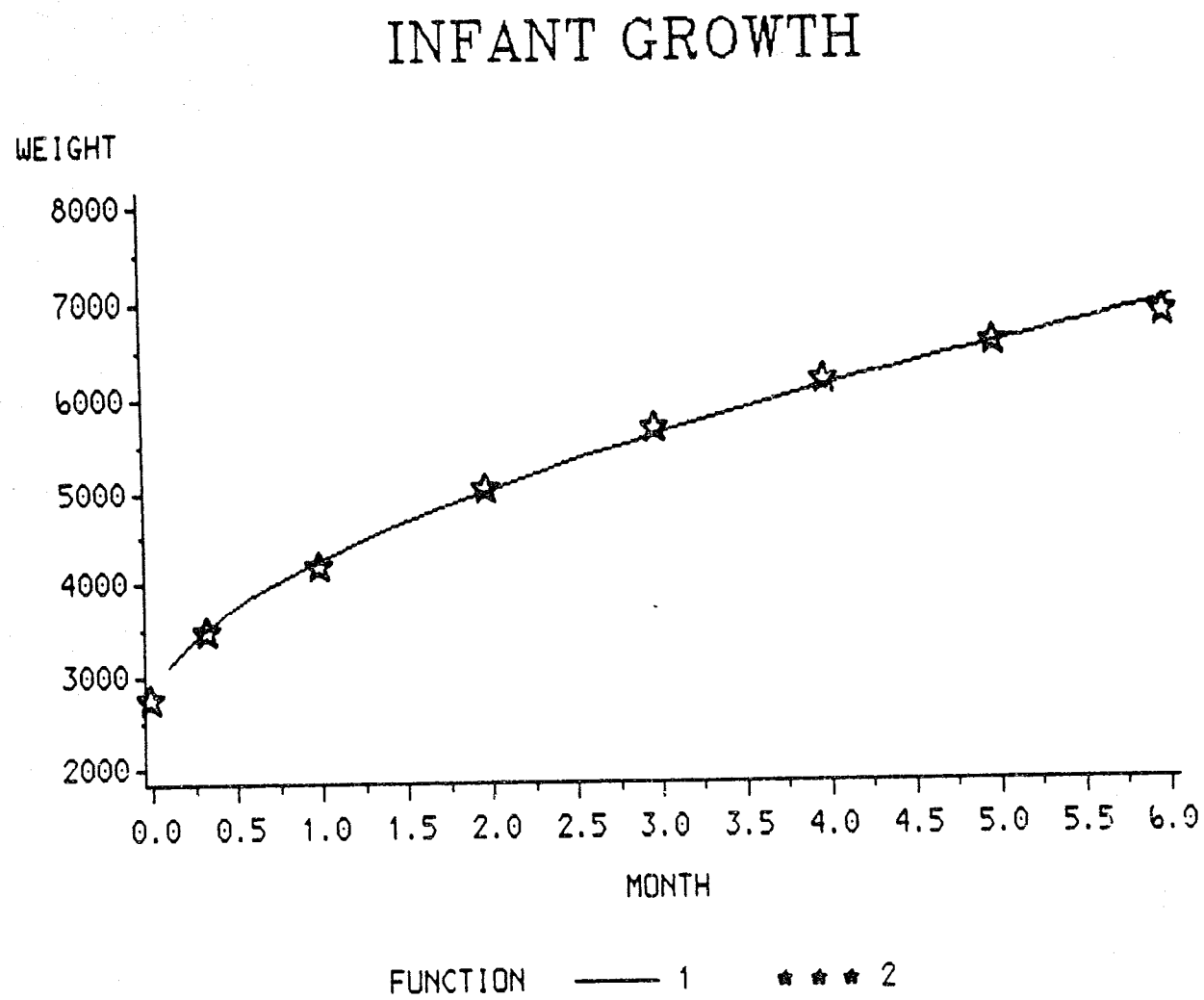


FIG 4.1. A model for infant weight from birth to 6 months of age with the LSMEANS

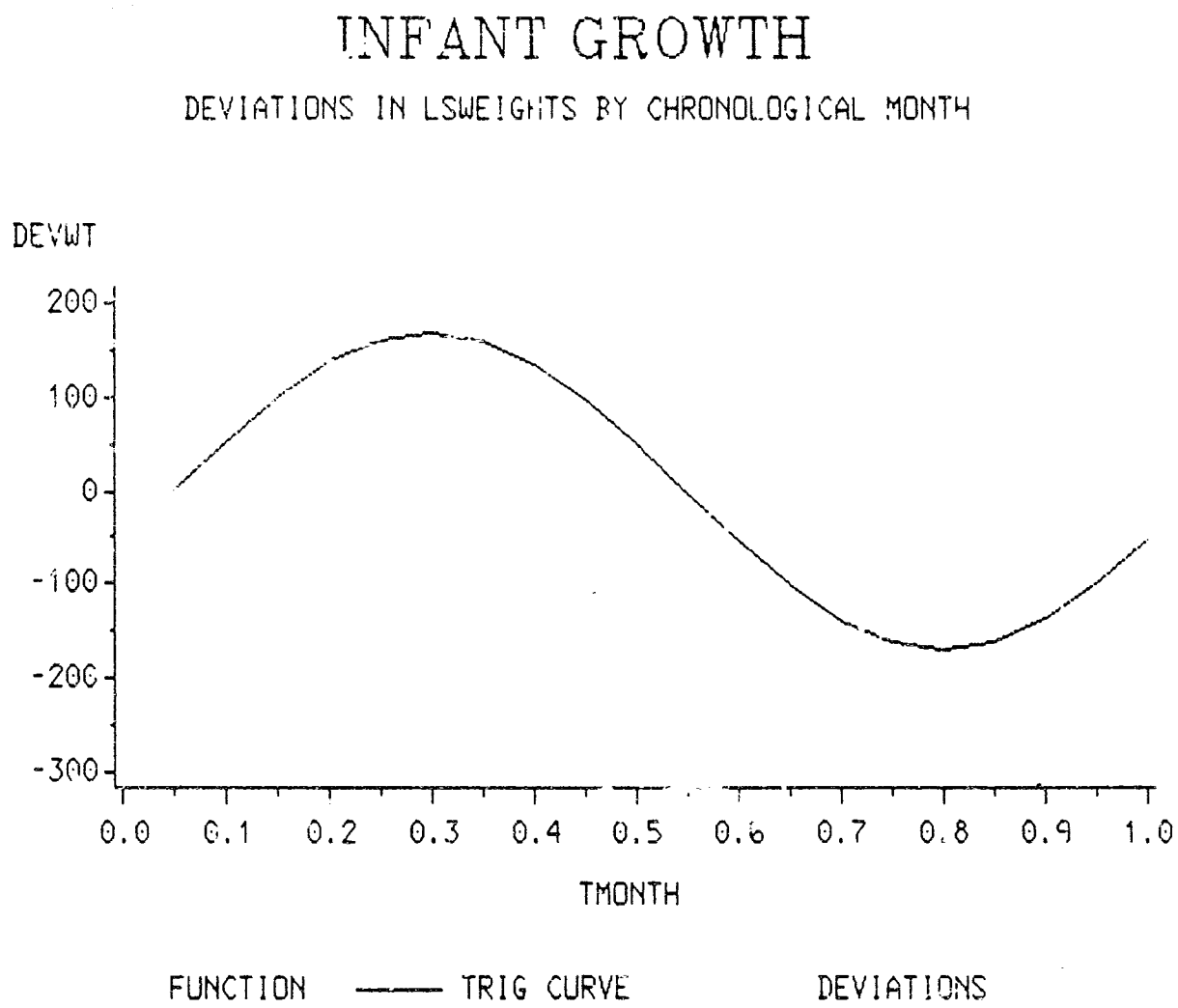


FIG 4.2. A model for infant weight showing deviations in LSMEANS by time of year

WEIGHT OF PREGNANT AND LACTATING WOMEN

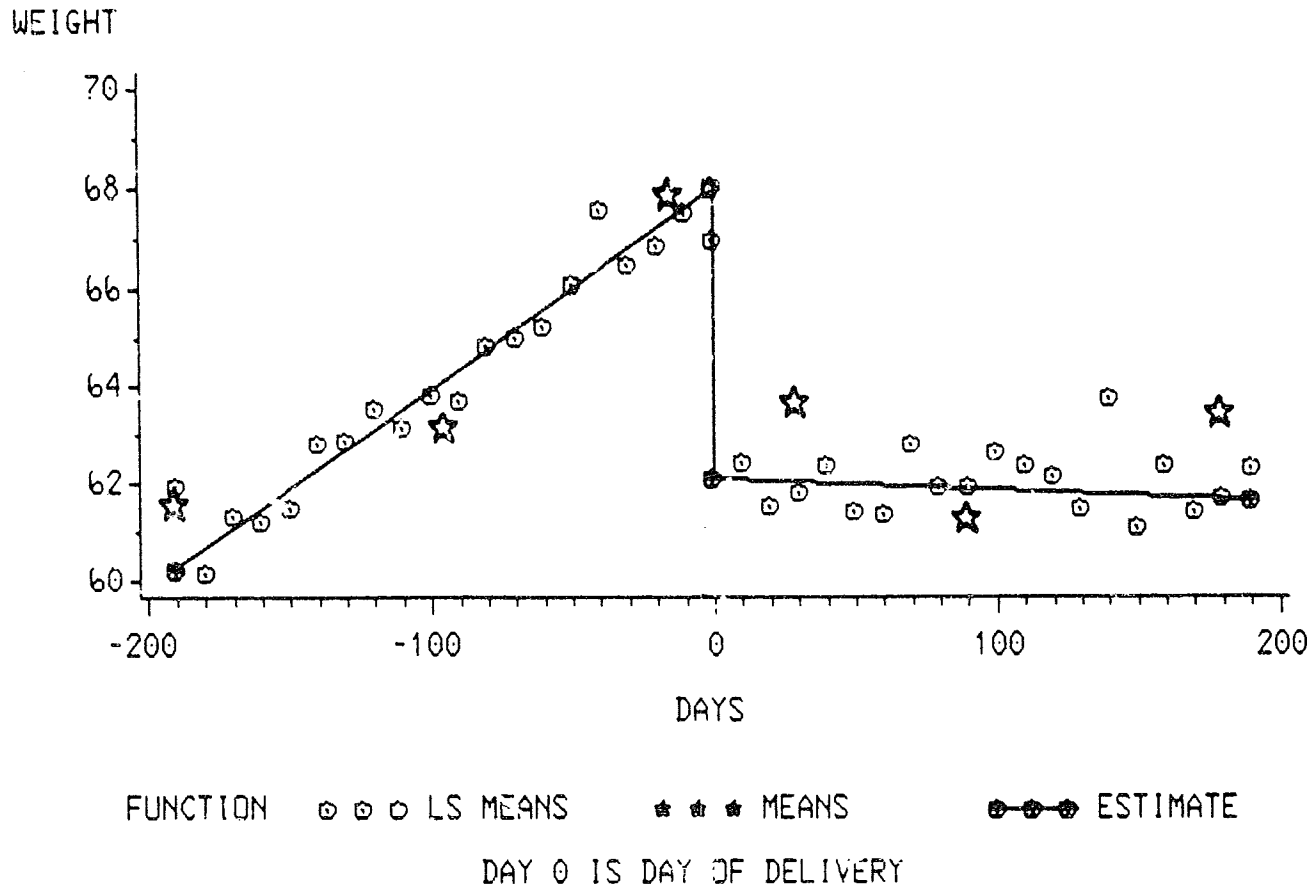


FIG 4.3. A model for weight of women during pregnancy and lactation

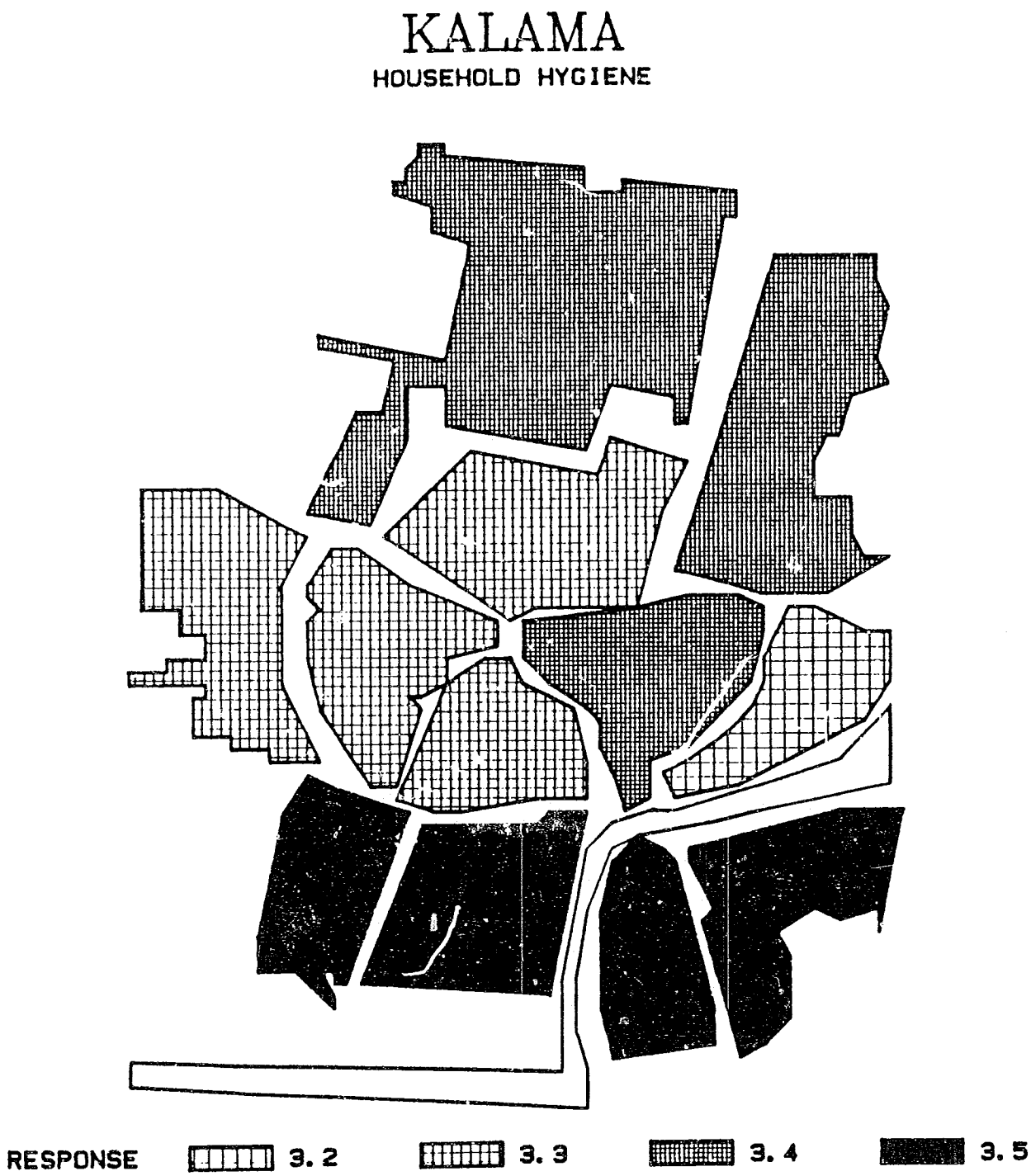


FIG 4.4. A map of the village Kalama showing geographical variation in average household sanitation-hygiene scores

Chapter 5

RESULTS AND DISCUSSION

I. THE TODDLER: MORBIDITY, GROWTH, FOOD INTAKE AND BEHAVIOR

One of the central hypotheses of the CRSP involves the relationships between food energy intake, growth, and illness experience of toddlers during the year from 18 to 30 months of age. Here we will describe the sample in terms of morbidity experience, growth, and food intake; then we will describe some of the relationships among these variables.

A. Morbidity of Toddlers

As expected, Kalama toddlers experienced a relatively high burden of illness, particularly of infectious disease. The average target toddler experienced 9.7 episodes of illness during the year. Proportionate morbidity by type of illness is shown in Table 5.1. The single largest contributor to illness in this age group was diarrhea; gastrointestinal illnesses, chiefly diarrhea, accounted for 34.2% of all recorded diagnoses. Respiratory illnesses accounted for the second largest proportion, 29.6% of illnesses. Skin infections made up 10.4% of illnesses; ear problems, 2.4%; eye problems, mostly conjunctivitis, 11.4%; fever 9.6%; two percent of diagnoses represented communicable diseases (12 cases of measles, eight of chicken pox and five of mumps).

Table 5.1.
Toddlers' morbidity* N = 133

Diagnosis	Number of Episodes	Duration, days x (range)	% severe	Percent of total morbidity
Skin				
Impetigo	59	7.7(3-29)	20.3	
Abcess/cellulitis	27	6.0(1-15)	100	
Fungal skin infection	11	13.0(3-29)	0	
Parasitic skin infection	7	8.0(4-15)	0	
Burns	5	5.2(4-7)	0	
Soft tissue injury	3	4.3(1-10)	0	
Flea bites	3	7.0(5-8)	0	
Uncertain	19	7.8(2-31)	15.8	
Total skin	134			10.4%

Table 5.1 continued

Diagnosis	Number of Episodes	Duration, days x (range)	% severe	Percent of total morbidity
Eye				
Conjunctivitis	121	5.3(1-32)	0	
Stye or blepharitis	10	4.5(3-8)	0	
Periorbital cellulitis	12	4.0(1-8)	0	
Trauma or foreign body	1	2	0	
Other	2	6.0(6)	0	
Total eye	146			11.4%
Ear				
Otitis externa	3	14.0(4-31)	33.3	
Otitis media	27	11.3(2-42)	88.9	
Trauma or foreign body	1	4	100	
Total ear	31			2.4%
Mouth, teeth, gums				
Gingivostomatitis	1	2	0	
Thrush	4	12.0(3-36)	25.0	
Total mouth	5			0.4%
Respiratory				
Cold	135	5.5(1-32)	28.9	Total URI
Chronic purulent rhinitis	6	10.8(6-15)	50.0	16.5%
Tonsillopharyngitis	71	5.4(1-19)	60.6	
Bronchitis	151	6.7(1-66)	100	Total LRI
Asthma or wheezing	2	5.5(3-8)	50.0	13.1%
Pneumonia	16	6.8(3-15)	100	
Total respiratory	381			29.6%
Digestive				
Acute vomiting/gastritis	57	4.1(1-18)	100	
Diarrhea	345	4.8(1-37)	65.8	
Dehydration	37	4.9(1-15)	100	
Jaundice	1	3	100	
Total digestive	440			34.2%
Extremities, Unspecified	1	6	0	
Communicable Diseases				
Measles	12	5.9(2-12)	100	
Chicken pox	8	4.5(3-8)	12.5	
Mumps	5	3.0(2-5)	0	
Total communicable	25			1.9%
Fever				
Without other signs and symptoms	41	3.8(1-13)	9.8	
With other findings	80	3.8(1-10)	100	
After immunization	3	5.3(4-8)	33.3	
Total fever	124			9.6%

Table 5.1 continued

Diagnosis	Number of Episodes	Duration, days x (range)	% severe	Percent of total morbidity
Total Diagnosed Illnesses:	1287.0	5.5(1-66)	57.7	
Total Illnesses per Child:	9.7			

* Includes only toddlers with 180 days or more of observation (69 males, 64 females).

Table 5.2 shows percent of time ill with all illnesses and selected categories of illness. The average percentage of days ill was 11.3 ± 8.3%; the median was 10% of time, and the range from zero to 36.8% of time. Diarrheal and respiratory illnesses each contributed more than one-third of time ill, a few toddlers had no illness during the time observed and 22.6% had no diarrhea. Twenty-six percent spent less than five percent of the observed time ill; but almost 30% were ill more than 15% of the time.

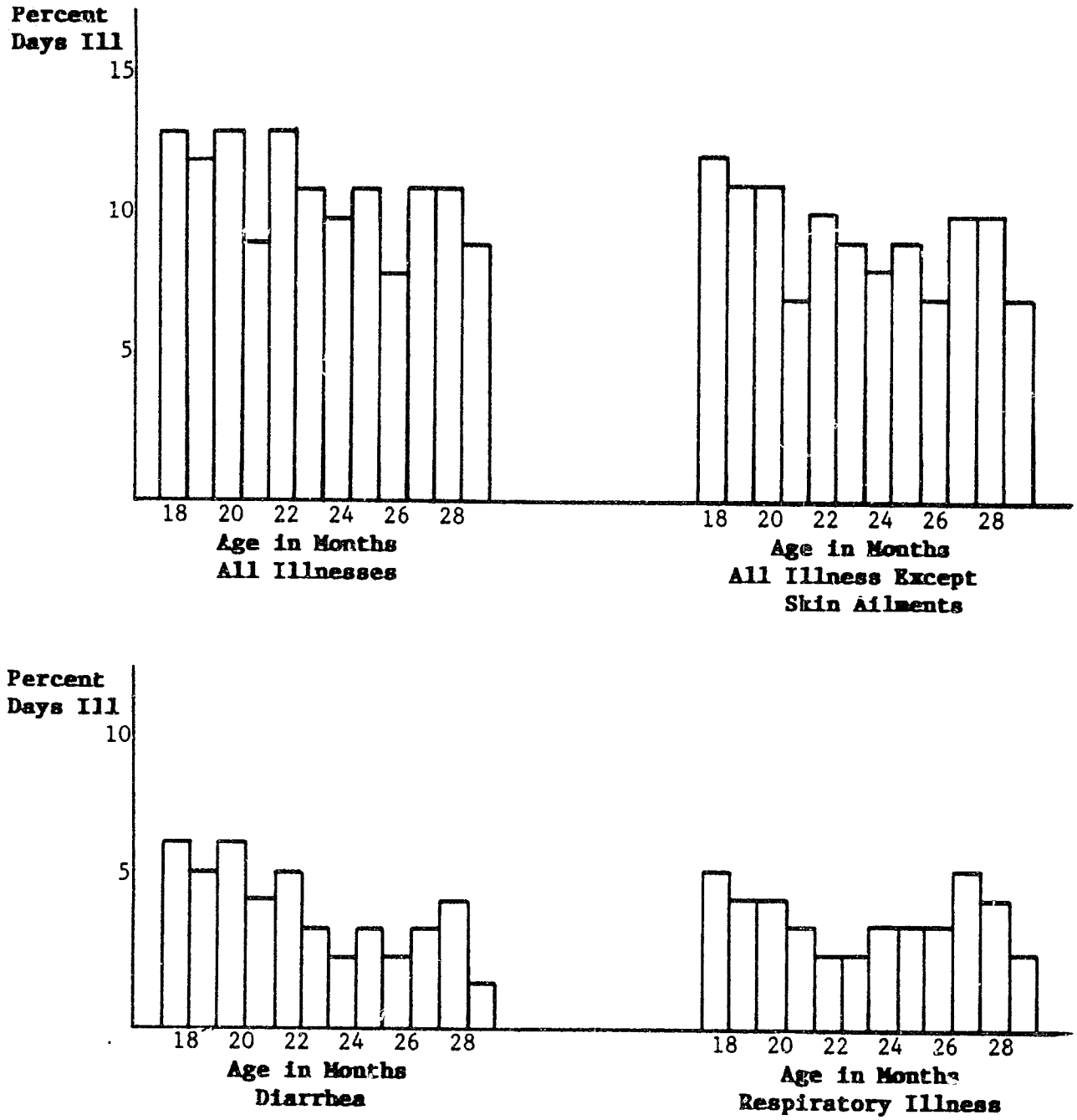
Table 5.2.
Time sick with selected illnesses*

% Days Ill	All Illnesses (N = 133)	All Illnesses Except Skin (N = 133)	Diarrheal Illnesses (N = 133)	Respiratory Illness (N = 133)
Mean	11.3	9.3	3.6	3.6
Standard deviation	8.3	7.6	4.4	4.3
Median	10.0	7.6	2.1	2.3
Range	0-36.8	0-36.8	0-26.8	0-23.6
% of toddlers with no time ill	8.3	9.0	22.6	24.8
% with 0-5% time ill	18.0	25.6	53.8	53.4
% with 5-10% time ill	24.1	27.1	15.0	11.3
% with 10-15% time ill	20.3	15.8	5.3	9.0
% with more than 15% time ill	29.3	22.6	3.8	1.5

* Based on toddlers with ≥ 180 days of observation

The data for diarrheal illness seem consistent with national figures, although no direct comparison is possible. The National Control of Diarrheal Diseases Project is following a cohort of more than 10,000 children under two years of age in five governorates; they report an average of 11% of days with diarrhea (Nasser, 1987). Given that diarrheal incidence is expected to decline with age, our figures for about 4% of time in 18 to 30-month- olds seem reasonable. Days with diarrhea was age related within the 18 to 30 month range, with a clear decline after about 23 months (see Figure 5.1).

Fig 5.1. Relation of morbidity to age in toddlers, least-squares mean percent of days ill for selected illnesses, adjusted for individual effect and time of year.



The data presented in Figures 5.1 and 5.2, and in several later presentations in this chapter, are in the form of "least squares means". The procedure for deriving these is detailed in the statistics section, but a brief intuitive explanatio will be given here for the sake of interpretability. The general linear models presented later to test relationships among the several variables allow the calculations of means and standard errors of the dependent variable conditioned upon specified independent variables, and simultaneously conditioned upon more than one independent variable if the analysis so specifies. Thus in Figure 5.1, morbidity is shown in relation to age controlled for time of year and for the "individual effect" (represented in the model by the subject's ID number). The individual effect variable controls for variation due to habitually or average high or low values for that subject. Least-square means are calculated as if the value of conditioning variables were their average value. The associated standard errors are computed after removing the variance due to the conditioning variables.

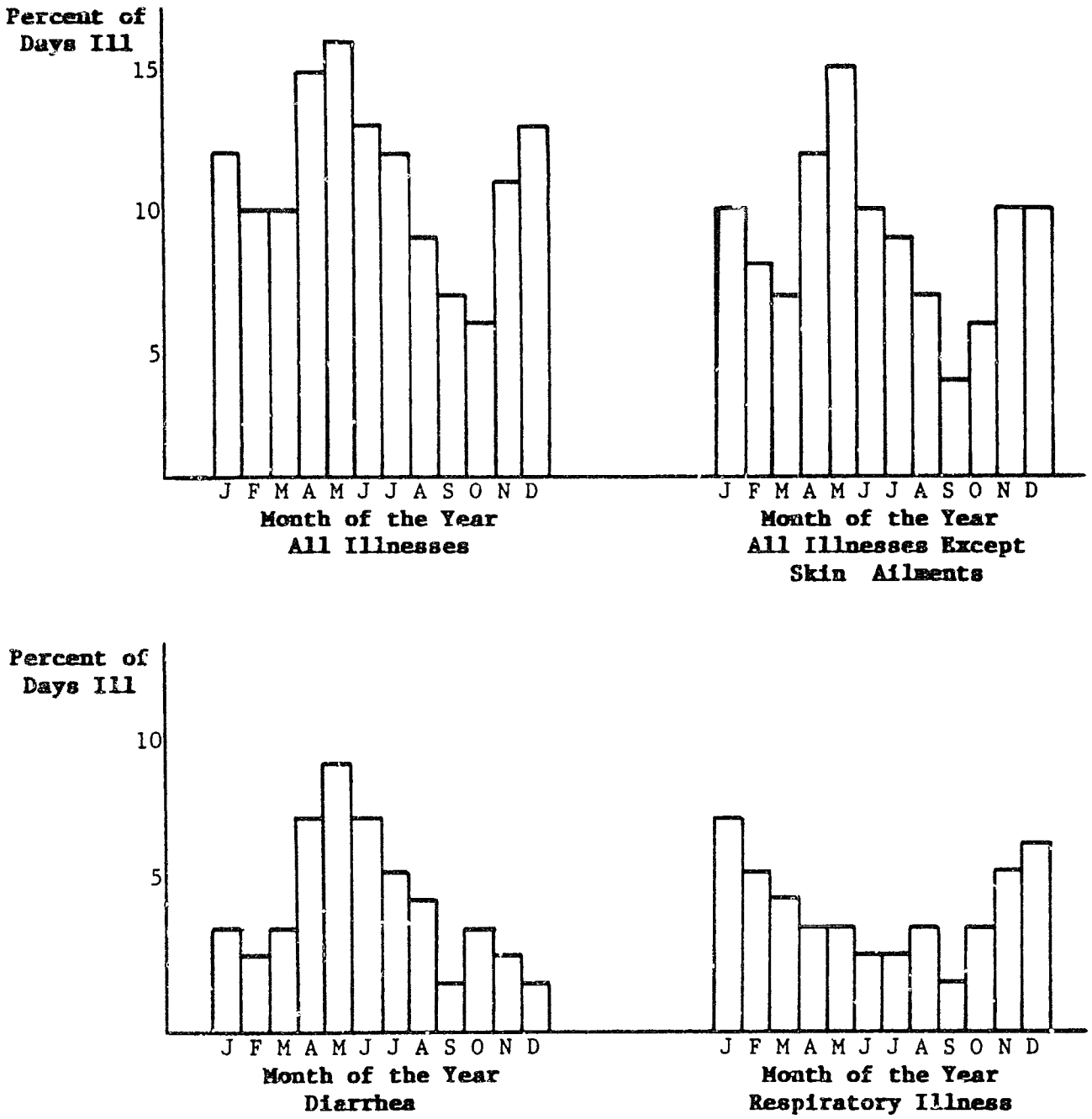
Some illnesses are clearly seasonal. Diarrhea is a summer disease, higher in the period from April through August and lowest from September through March (Figure 5.2). Respiratory infections show an opposite trend, with the peak in November through February. Measles peaks in January-February, as it does in the country as a whole, but affects the CRSP data less because of the relative small number of cases. September and October are low points for total illness, with the impact of diarrhea raising total days sick to their peak in April through June and a secondary peak reflecting respiratory illness in November through January.

The four toddlers who died during the study experienced morbidity patterns similar to the others, with a relatively higher proportion of diarrheal illness and of severe illness (Table 5 3).

Table 5.3.
Morbidity of toddlers who died (N = 4)

Diagnosis	Number of Episodes	Mean Duration (days)	% of Episodes Severe	% of Total Morbidity
Cold	1	6	100	
Tonsillopharyngitis	1	6	100	
Bronchitis	1	8	100	(11.1%)
Vomiting	3	5.3	100	
Diarrhea	14	5.4	64.3	
Dehydration	5	7.0	100	(81.5%)
Fever alone	1	3	0	
Fever with other findings	1	6	100	(7.4%)
Total	27			

Fig 5.2. Seasonal aspects of morbidity in toddlers, least-squares mean percent of days ill for selected illnesses, adjusted for individual effect and age.



B. Growth of Toddlers.

1. Weight, Length and Weight-for-Length

At the age of 18 months, Kalama toddlers as a group were moderately stunted but not wasted. This is typical of the preschool population throughout Egypt and most likely reflects earlier chronic malnutrition and/or infectious disease burden, as shown by the fact that economically advantaged Egyptian children are essentially identical to international standards for height as well as weight (USAID, 1978). Tables 5.4, 5.5, and 5.6 present the weights of CRSP toddlers monthly by age; Tables 5.7, 5.8, and 5.9 show lengths; and Tables 5.10 and 5.11 show weight-for-length in absolute terms, as percent of the median and as mean Z-score relative to the international standards (CDC, 1985). At 18 months, the average Kalama child was at about the 3rd percentile for length, or about 2 standard deviations below the median of the international standards. The situation for boys and girls was essentially identical in relation to the reference population, with girls' absolute length about 1.5 cm shorter than boys. Over the course of the year, there was an increase in length-for-age for both sexes relative to standards, to an average Z-score of -1.7. Weight-for-age showed a less dramatic deficit at 18 months, and a similar improvement over the year, from a mean Z-score relative to international standards of -1.1 at 18 months to about -0.7 at 30 months. Weight-for-height started and finished the study period within normal limits, but with a slight and steady increase over the year. The mean Z-score started out at approximately zero, and by 30 months was about +0.4.

Table 5.4.
Weight by age, sexes combined

Age in Months	N	Mean (Kg)	Standard Deviation (Kg)	Mean Percent of Reference Median	Z-Score Mean
18	96	9.95	1.43	88.7	-1.07
19	64	10.04	1.17	87.6	-1.18
20	75	10.36	1.60	89.3	-1.01
21	73	10.37	1.47	88.2	-1.12
22	70	10.67	1.40	89.6	-0.99
23	78	10.81	1.59	89.2	-1.03
24	63	11.15	1.40	91.7	-0.88
25	70	11.32	1.23	91.8	-0.87
26	77	11.54	1.36	92.1	-0.82
27	61	11.79	1.79	92.7	-0.79
28	78	11.98	1.31	92.4	-0.78
29	87	12.29	1.59	93.3	-0.70

Table 5.5.
Weight by age, males

Age in Months	N	Mean (Kg)	Standard Deviation (Kg)	Mean Percent of Reference Median	Z-Score Mean
18	53	10.25	1.17	89.1	-1.06
19	37	10.17	1.19	86.7	-1.28
20	38	10.87	1.60	91.3	-0.84
21	34	10.80	1.57	89.3	-1.02
22	32	11.15	1.24	90.8	-0.88
23	41	11.20	1.61	90.0	-0.94
24	31	11.46	1.64	92.1	-0.88
25	36	11.53	1.22	91.7	-0.92
26	38	11.89	1.42	93.1	-0.77
27	28	12.23	1.96	94.2	-0.68
28	44	12.26	1.28	93.1	-0.72
29	44	12.58	1.76	93.9	-0.66

Table 5.6.
Weight by age, females

Age in Months	N	Mean (Kg)	Standard Deviation (Kg)	Mean Percent of Reference Median	Z-Score Mean
18	43	9.58	1.63	88.2	-1.09
19	27	9.86	1.15	88.9	-1.03
20	37	9.84	1.44	87.4	-1.19
21	39	9.99	1.29	87.3	-1.20
22	38	10.27	1.42	88.5	-1.09
23	37	10.38	1.48	88.3	-1.12
24	32	10.84	1.07	91.2	-0.88
25	34	11.09	1.22	91.9	-0.83
26	39	11.21	1.22	91.3	-0.88
27	33	11.41	1.58	91.4	-0.88
28	34	11.61	1.27	91.5	-0.86
29	43	11.99	1.36	92.7	-0.75

Table 5.7.
Height by age, sexes combined

Age in Months	N	Mean (Cm)	Standard Deviation (Cm)	Mean Percent of Reference Median	Z-Score Mean
18	91	75.98	3.48	92.7	-1.94
19	56	77.11	3.01	92.7	-1.95
20	69	78.15	3.92	93.1	-1.82
21	68	78.27	3.64	92.4	-2.01
22	68	78.92	4.16	92.2	-2.04
23	78	79.74	3.58	92.3	-2.03
24	60	80.02	3.35	93.3	-1.78
25	69	81.09	3.72	94.2	-1.54
26	74	81.23	3.75	93.5	1.70
27	58	81.86	3.94	93.4	-1.72
28	73	82.88	3.41	93.6	-1.67
29	83	83.57	3.58	93.4	-1.71

Table 5.8
Height by age, males

Age in Months	N	Mean (Cm)	Standard Deviation (Cm)	Mean Percent of Reference Median	Z-Score Mean
18	50	76.78	3.10	93.0	-1.89
19	35	77.19	3.17	92.2	-2.09
20	37	78.75	3.69	93.2	-1.81
21	31	78.70	3.85	92.1	-2.07
22	33	79.95	4.09	92.7	-1.91
23	42	80.33	3.66	92.4	-1.99
24	30	80.79	3.61	93.7	-1.67
25	35	81.95	3.33	94.6	-1.43
26	35	81.67	3.68	93.5	-1.72
27	26	82.57	4.02	93.6	-1.67
28	42	83.65	3.32	94.0	-1.56
29	42	84.16	3.50	93.6	-1.65

Table 5.9.
Height by age, females

Age in Months	N	Mean (Cm)	Standard Deviation (Cm)	Mean Percent of Reference Median	Z-Score Mean
18	41	74.99	3.70	92.4	-2.00
19	21	76.99	2.78	93.4	-1.73
20	32	77.46	4.11	93.0	-1.83
21	37	77.91	3.46	92.6	-1.95
22	35	77.94	4.05	91.8	-2.17
23	36	79.06	3.41	92.2	-2.07
24	30	79.26	2.94	92.9	-1.88
25	34	80.20	3.93	93.7	-1.65
26	39	80.83	3.82	93.5	-1.69
27	32	81.29	3.84	93.2	-1.77
28	31	81.84	3.32	92.9	-1.82
29	41	82.97	3.59	93.1	-1.77

Table 5.10.
Weight for height by age, males

Age in Months	N	Mean (Kg)	Standard Deviation (Kg)	Mean Percent of Reference Median	Z-Score Mean
18	50	0.1333	0.012	100.5	0.01
19	34	0.1306	0.012	98.1	-0.27
20	36	0.1391	0.018	103.3	0.32
21	31	0.1380	0.017	102.4	0.23
22	31	0.1388	0.012	102.0	0.19
23	37	0.1382	0.015	101.2	0.09
24	29	0.1405	0.016	101.7	0.03
25	34	0.1420	0.013	101.9	0.07
26	34	0.1454	0.014	105.0	0.36
27	26	0.1460	0.018	104.0	0.27
28	41	0.1463	0.013	103.7	0.24
29	41	0.1501	0.016	105.8	0.43

Table 5.11.
Weight for height by age, females

Age in Months	N	Mean (Kg)	Standard Deviation (Kg)	Mean Percent of Reference Median	Z-Score Mean
18	41	0.1274	0.019	100.4	0.07
19	21	0.1328	0.009	102.4	0.29
20	31	0.1284	0.014	99.0	-0.09
21	36	0.1279	0.014	98.0	-0.22
22	35	0.1300	0.014	99.8	0.01
23	35	0.1332	0.014	100.5	0.08
24	29	0.1370	0.011	102.6	0.23
25	32	0.1387	0.011	102.7	0.19
26	38	0.1386	0.011	102.4	0.17
27	30	0.1413	0.014	103.9	0.30
28	31	0.1421	0.012	104.1	0.31
29	41	0.1434	0.013	104.3	0.34

The figures as presented above mask considerable variability. Using height- for-age as our most affected measure, at 18 months approximately 24% of CRSP toddlers were below a Z-score of -2.5; approximately 35% were between -2.5 and -1.5; and approximately 36% were -1.5 or better.

Figures 5.3-5.5 show the least-squares means and standard errors for weight, length, and weight-for-length by age, controlling for sex, individual effect, time of year. Figure 5.6 shows the trends in least-squares mean Z-scores relative to the NCHS reference population controlled similarly.

The apparent change between 23 and 24 months is probably artifactual, since the reference population assumes that supine length is measured until 24 months, and stature from 24 months onward. Supine length was measured for CRSP toddlers throughout the study.

Weight gain in the period 18-30 months was linear for the target sample, and while the intercepts differed [illegible] boys and girls (as expected), the slopes did not. Length, however, exhibited a different pattern. Girls began the study shorter than boys (although not different in relation to the reference population) but grew more rapidly, ending at 30 months, at about the same average length as boys (see Figure 5.7).

FIG 5.3. Least-squares mean weight by age, controlled on time of year, sex, and individual effect (± SE) n = 892 observations

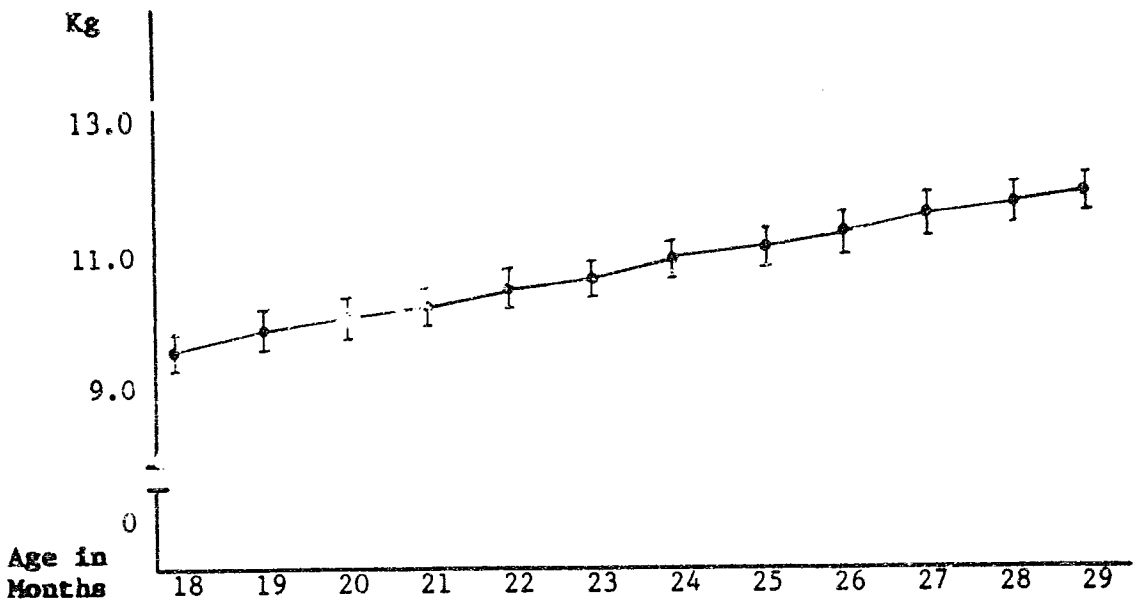


FIG 5.4. Least-squares mean height by age, controlled on time of year, sex, and individual effect (± SE) n = 847 observations

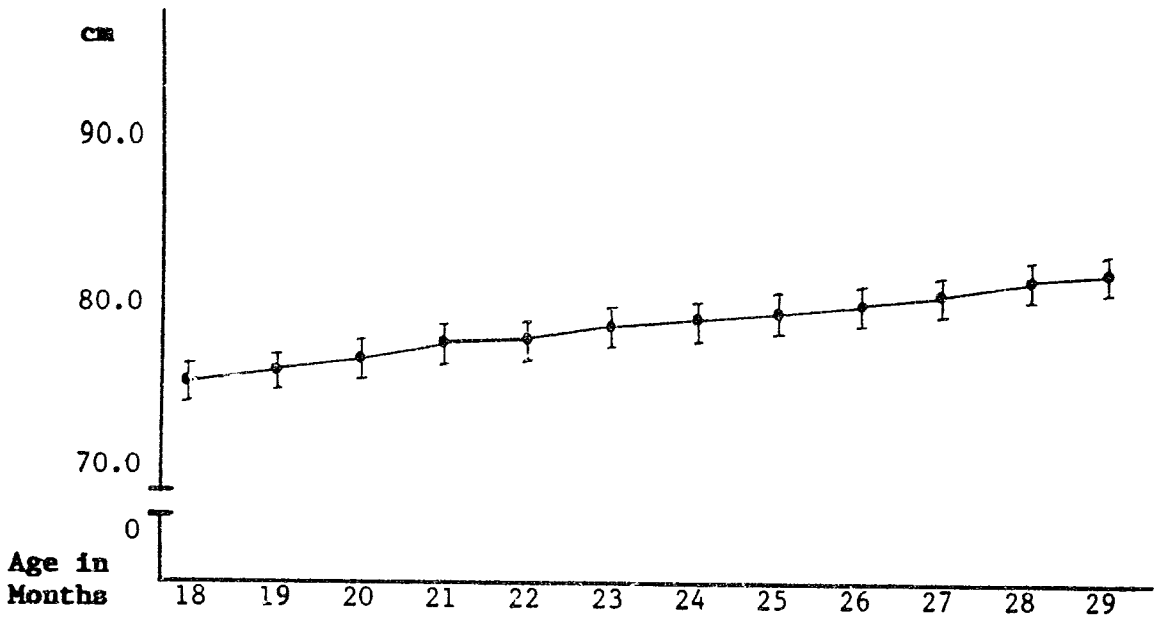


FIG 5.5. Least-squares mean weight/height by age, controlled on time of year, sex, and individual effect (± SE) N = 824 observations

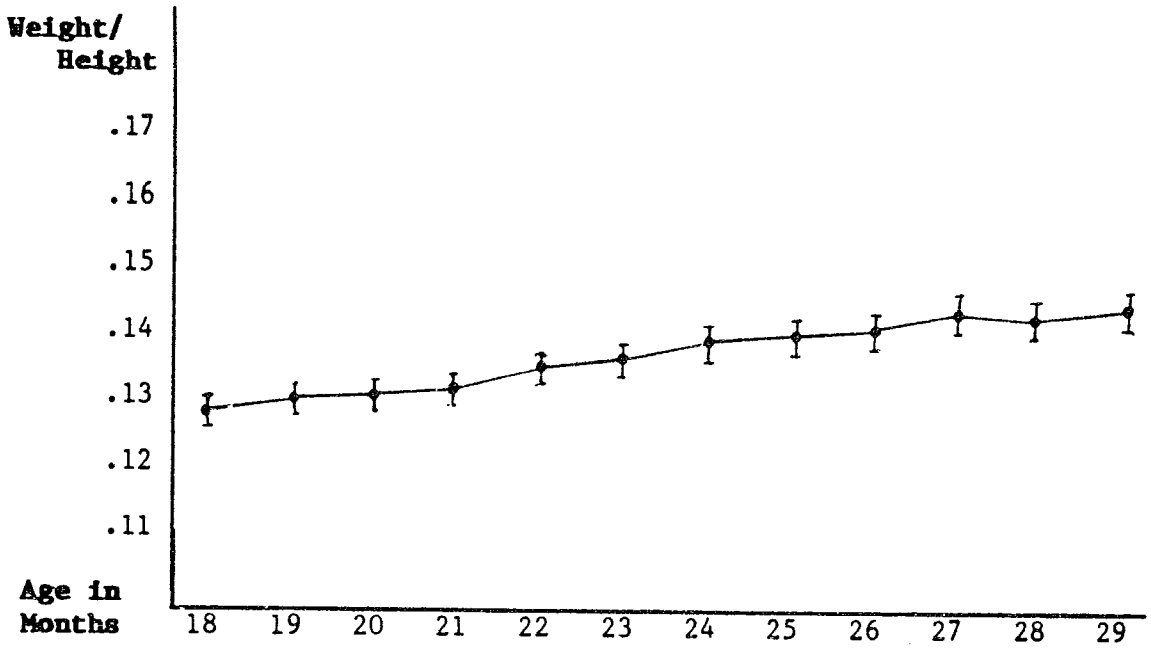


FIG 5.6. Least-squares mean z-scores in relation to reference population, controlled for time of year, sex, and individual effect

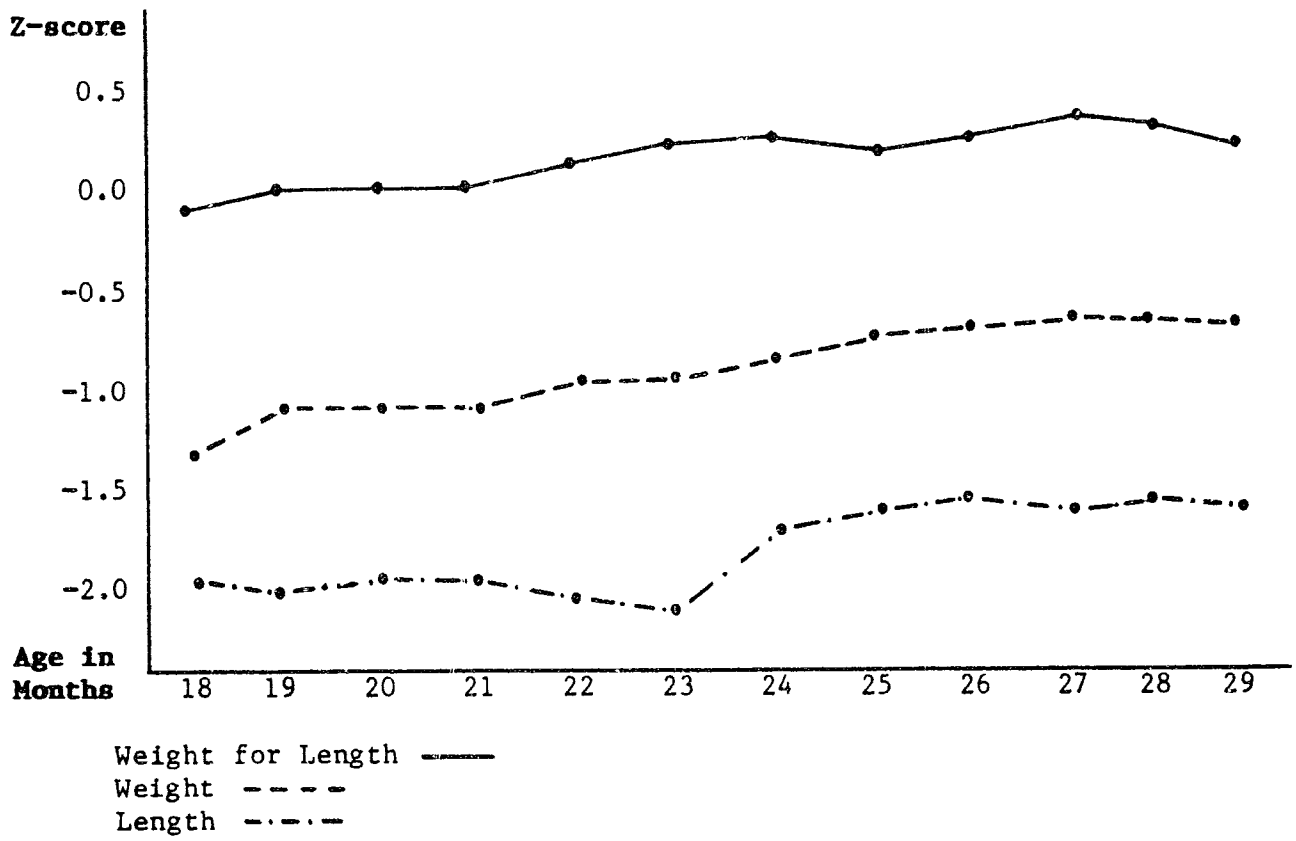
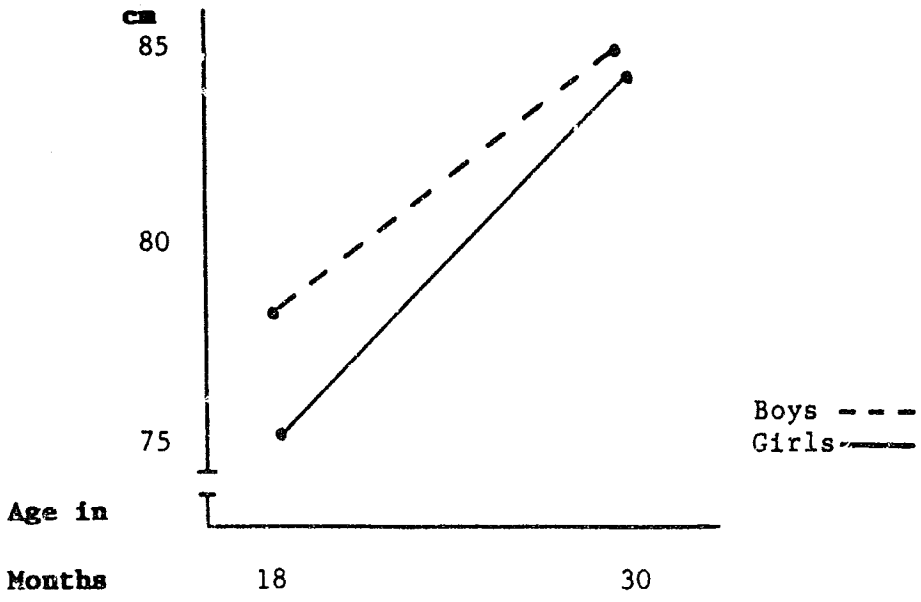


FIG 5.7. Least-squares means for length, controlled for time of year and individual effect



2. Seasonal Effects

There were clear seasonal effects on growth (see Figure 5.8). While these do not represent velocity curves, they give much the same information without the problems of subtraction of two measures in a short period of time with doubling of technical error. Weight, other things being equal, was greatest in the winter months and lowest in the period April through July. This pattern, which has been documented in at least one other study in rural Egypt (Afifi, 1985), is consistent with the hypothesis that diarrheal illness has a major impact on weight gain. Length, controlled for other factors, is lowest in November and December.

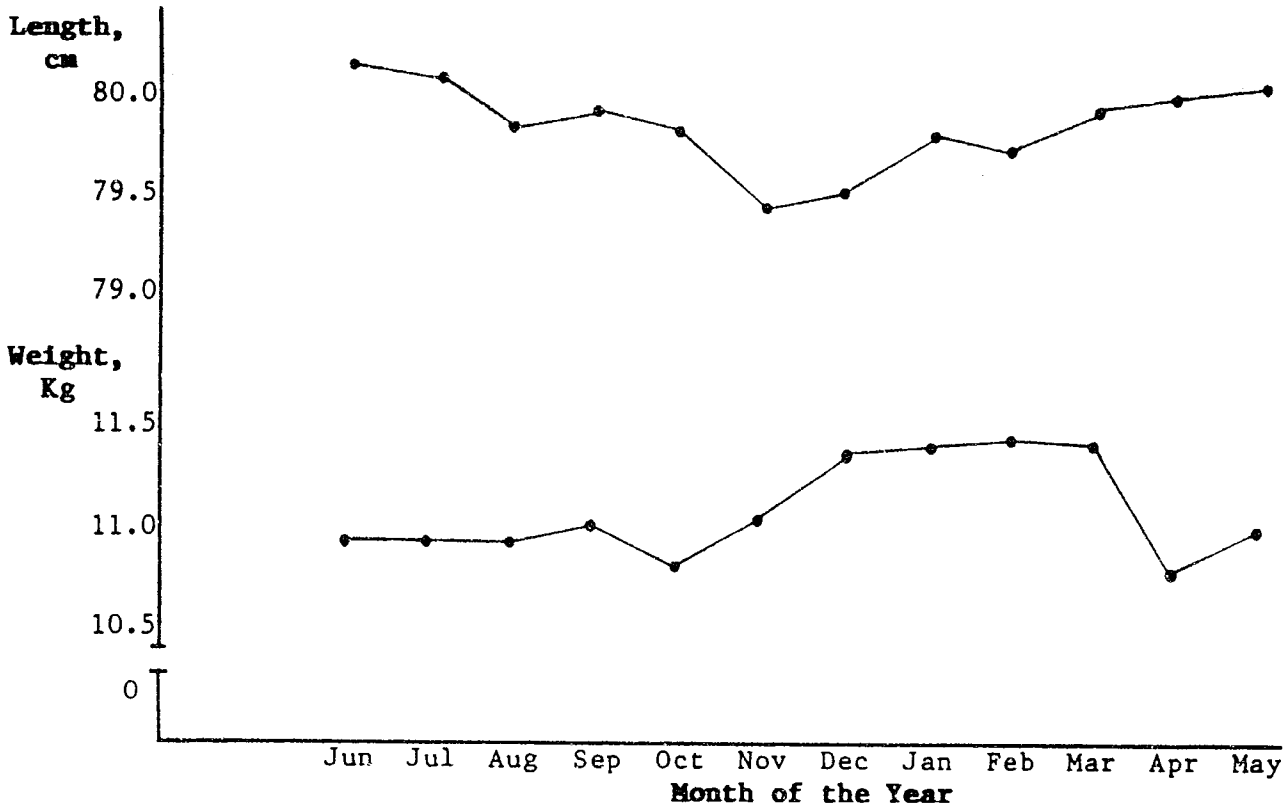
Interpretation of these complex patterns is not immediately obvious, but speculations can be made. Children reaching the group mean age in January through April were somewhat taller than children reaching that age in the summer and fall. An effect of time of year is also seen with attained weight at the group mean age. It seems clear that there are seasonal variations in growth rate which are strong enough to be seen in these analyses of attained weight and length.

C. <u>Food Intake of Toddlers.</u>

At the time of writing this report, the Egypt project is still resolving problems in its food composition database. Food energy intakes reported here are based on carbohydrate X 4 + protein X 4 + fat X 9, except for a few foods for which we have corrected energy value based on laboratory analysis. An interviewer-effect correction has also been incorporated.

The measurement of food intake was also complicated by the fact that some toddlers were still receiving breast milk beyond the age of 18 months. The selection of this age period for the CRSP design was a compromise between the need for complete measurement of food intake (assumed to be possible in all three countries by approximately 18 months) and the need for early measurement of cognitive development. The actual situation in Egypt was that a substantial proportion of toddlers still received breast milk beyond 18 months. The cultural ideal is to breast feed until the second birthday, in accord with Koranic recommendation. In practice, 38% of male target toddlers and 44% of females

FIG 5.8. Least-squares mean (± SE) for length, and weight by time of year, controlled for sex, age, and individual effect



had been completely weaned prior to age 18 months; the remainder continued to receive some breast milk for variable periods of time after study entry; almost all were completely weaned by age 24 months (see Figure 5.9).

Tables 5.12 and 5.13 show median intakes of non-breast milk energy (kcal/day and kcal/kg/day) by age for boys and girls by breast feeding status. "Weaning" here is the recorded weaning date, although occasional breast milk may show up for some children after that date.

FIG 5.9. Percent of target toddlers who had a food intake measurement in a given month who were partially breast-fed by age

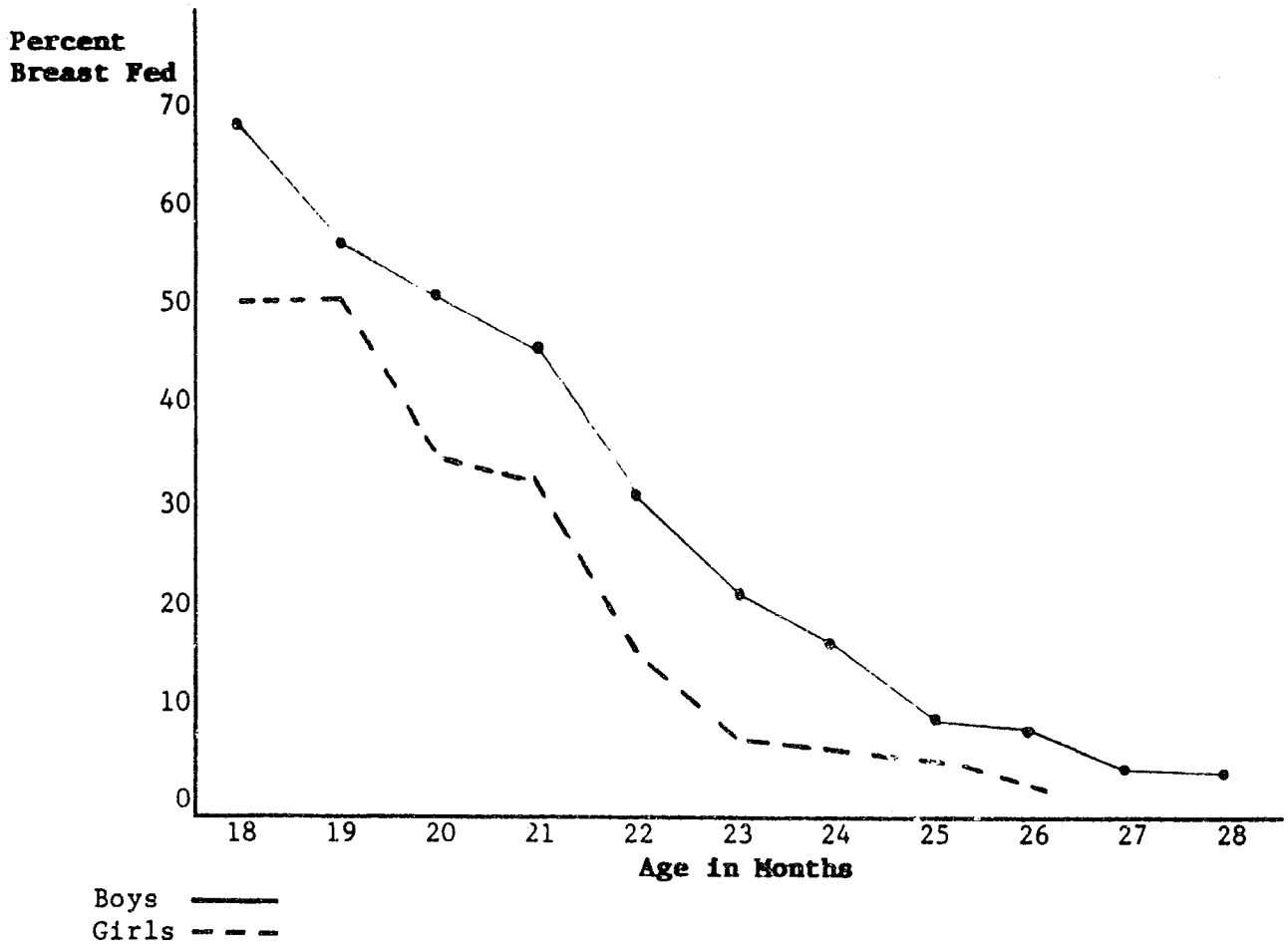


Table 5.12.
Median toddler food intake (non-breast milk), kcal/day

Age in Months	Males		Females	
	Weaned	Not Yet Weaned	Weaned	Not Yet Weaned
18	959 (21)*	728 (42)	931 (25)	773 (26)
19	925 (25)	763 (32)	978 (24)	815 (26)
20	1078 (29)	819 (25)	999 (27)	1009 (18)
21	988 (32)	847 (20)	1081 (33)	832 (14)
22	1052 (42)	925 (16)	1102 (40)	830 (8)
23	1011 (47)	1052 (9)	1154 (43)	904 (5)
24	1156 (46)	847 (9)	1133 (44)	660 (1)
25	1025 (54)	1083 (4)	1041 (39)	908 (2)
26	1052 (53)	963 (4)	1346 (46)	
27	1062 (55)	1801 (1)	1047 (45)	
28	1136 (49)	1026 (1)	1133 (46)	
29	1119 (50)		1092 (44)	

* (N)

Table 5.13.
Median toddler food intake (non-breast milk), kcal/kg/day*

Age in Months	Males		Females	
	Weaned	Not Yet Weaned	Weaned	Not Yet Weaned
18	86 (16)	68 (36)	98 (23)	78 (21)
19	93 (21)	72 (27)	97 (21)	78 (21)
20	102 (22)	82 (22)	108 (25)	109 (14)
21	94 (26)	71 (17)	116 (28)	84 (12)
22	98 (34)	80 (15)	109 (35)	82 (6)
23	90 (38)	101 (9)	107 (36)	94 (3)
24	107 (40)	133 (8)	104 (35)	65 (1)
25	86 (48)	104 (3)	102 (34)	83 (2)
26	89 (45)	99 (3)	115 (37)	
27	90 (48)	180 (1)	98 (38)	
28	89 (43)		95 (40)	
29	89 (42)		94 (39)	

* Estimated weight based on regression of weight on age for each subject

Table 5.14 and Figure 5.10 show the least-squares means (Standard Error) for the same data, adjusted for sex and individual effect. Several points are relevant. First, although a few toddlers continued partial breast feeding after age 22 months (Figure 5.9), their non-breast milk intakes were essentially identical to that of those who were weaned after that time, and the number is too small for adequate comparison. Second, the difference in least-squares means between

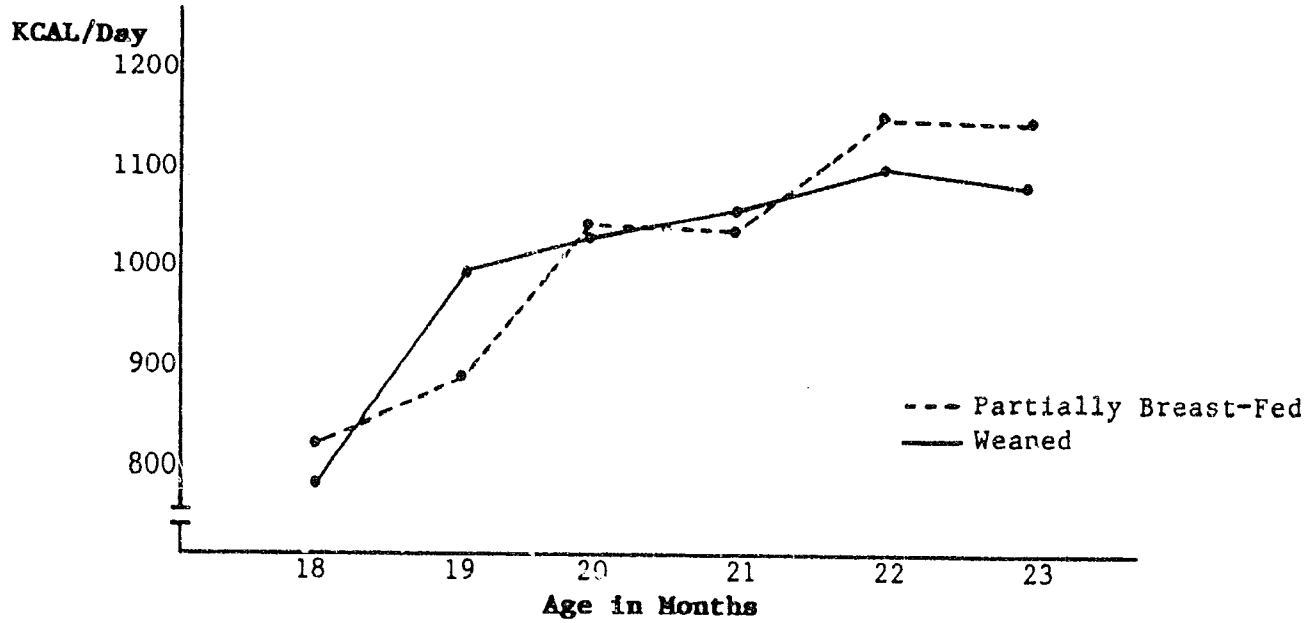
the two groups prior to 22 months is about 10 kcal/kg/day, indicating a significant contribution of breast milk to total intake at this age.

Table 5.14.
Energy intake of toddlers by age; least-square means, adjusted for individual effect and breast feeding status

Age in Months	Kcal	(SE)	Kcal/Kg*	(SE)
18	839	(31)	84	(3)
19	907	(32)	92	(3)
20	990	(33)	99	(3)
21	971	(34)	95	(3)
22	1075	(34)	103	(3)
23	1080	(35)	100	(3)
24	1072	(36)	98	(4)
25	1025	(37)	91	(4)
26	1151	(37)	101	(4)
27	1096	(38)	95	(4)
28	1084	(39)	90	(4)
29	1120	(39)	89	(4)

* Estimated weight based on regression of weight on age for each subject

FIG 5.10. Energy intake from non-breast milk sources for weaned and partially breast fed toddlers (least-squares means controlled for sex and individual effect)



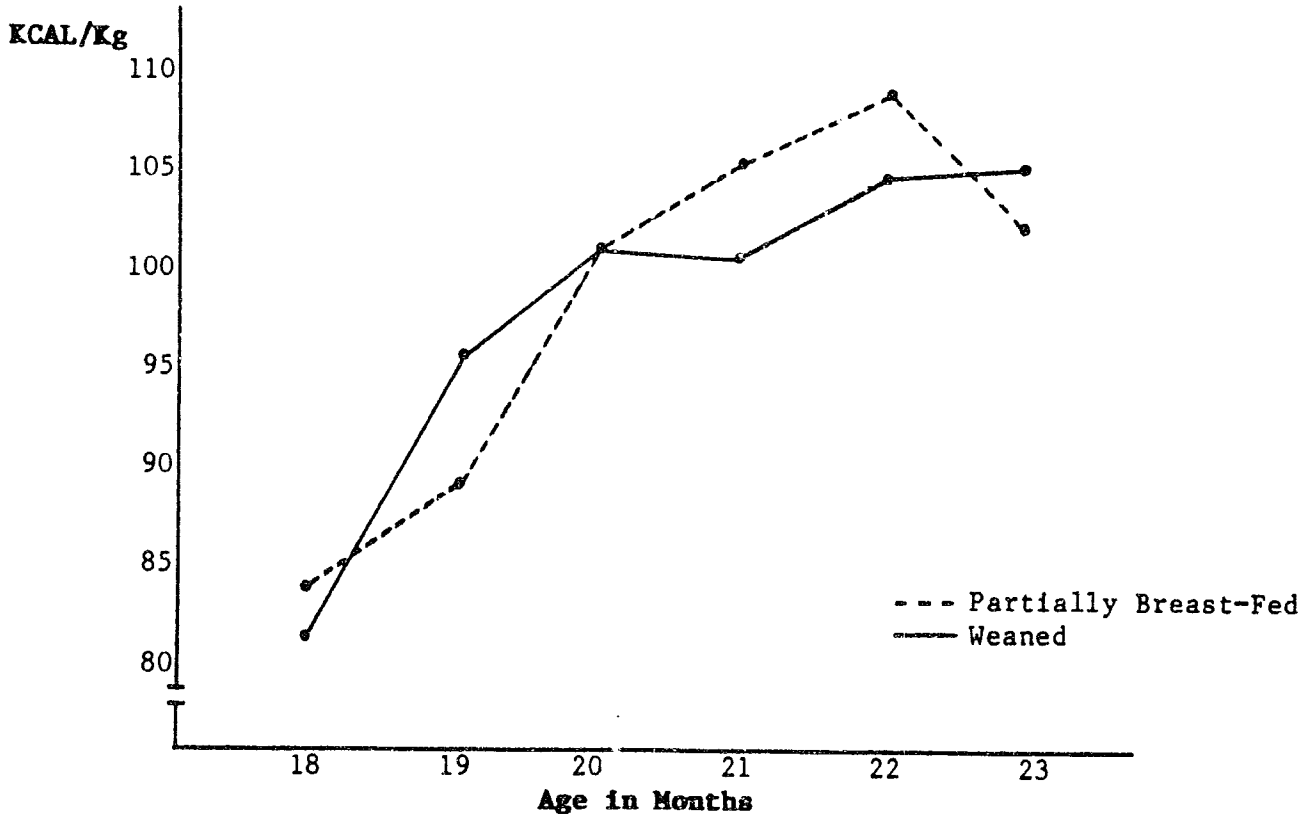
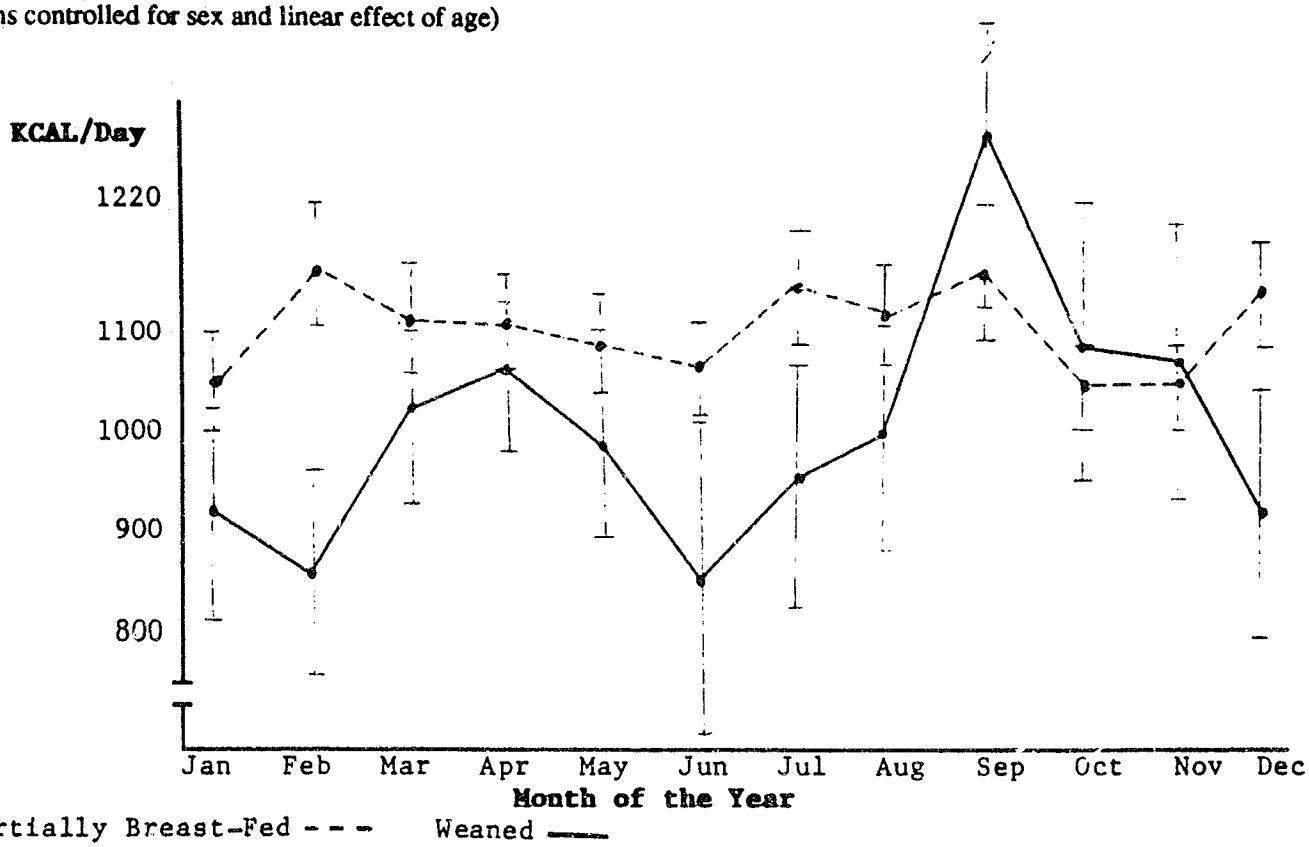


FIG 5.11. Food intake (non-breast milk) by time of year for weaned and partially breast fed toddlers (least-squares means controlled for sex and linear effect of age)



Food energy intake did not show any major seasonal variation. The general linear model predicting food intake from sex, age, time of year and breast feeding status accounted for about 50% of the variance, whether kcal/day or kcal/kg/day was the dependent variable. Figure 5.11 shows that for non-breast-fed children, the month of the year had no association with energy intake. For partially breast-fed children, there appeared to be an increase in non-breast milk food intake in September-November; this showed as a significant interaction term (breast feeding status versus time of year) only for the model predicting kcal/kg/day. It is of interest to note that September to November is also the period of the lowest prevalence of diarrhea; it is possible that mothers feel freer to give supplementary foods to the breast fed child when risk of diarrhea is low.

Various attempts were made to model breast milk intake, in order to be able to use food intake data for the whole sample over the entire year. None was successful as there was no uniform pattern of change in non-breast milk energy intake in relation to weaning date. Therefore, no attempt has been made to estimate breast milk intake in the analytical models which are discussed in the following sections; rather, the models have included a variable to account for breast-feeding status.

D. Relationships Between Variables

Within the 3-month periods from 18 to 20 months of age, 21-23, 24-26, 27-29 and over the entire one-year study period, the relationship between food (non-breast milk) energy intake and "growth" (ending versus beginning weight for the period) was small and not consistent.

Bivariate correlations between various pairs of variables result in the inescapable conclusion that girls and boys are, in this age group and in this community, quite different in many ways (see Table 5.20). We have already seen the difference in weaning patterns (Figure 5.9). For males, the average energy intake/kg from non-breast milk sources was significantly negatively related to weight at 24 months (actually to the intercept of the regression line of weight on age); the r was -.40. Since average kcal/kg reflects in part the breast feeding status of the child (those weaned earlier have on the average, higher kcal/kg) we may conclude that those children who had been weaned prior to 18 months of age

were generally smaller at 24 months than those who were still partially breast fed. For boys, average kcal/kg was significantly and negatively related to all measures of average size over the year (height, weight, weight-for-height), while for girls there was no relationship between average kcal and average size measures.

Table 5.15.
Bivariate correlations between key variables over the entire study period (sexes combined)

Variables	Correlation Coefficient (r)*
Average Kcal/Kg vs Intercept of Weight Regressed on Age	**-.51**
Average Kcal/Kg vs Average Weight Z-score	**-.49**
Average Kcal/Kg vs Average Weight	**-.53**
Average Kcal/Kg vs Average Height Z-score	**-.36**
Average Kcal/Kg vs Average Height	**-.39**
Average Kcal/Kg vs Average Wt/Ht Z-scores	**-.38**
Average Kcal/Kg vs Average Weight/Height	**-.48**
Average Kcal/Kg vs Socioeconomic Status	ns
Growth* vs Average Kcal/Kg	ns
Growth vs Percent of Days Sick	ns
Growth vs Percent of Days with Diarrhea	ns
Growth vs Household Size†	.24
Growth vs Socioeconomic Status	ns
Sanitation/Hygiene Score vs Average Height Z-Scores	.32
Sanitation/Hygiene vs Average Weight Z-score	-.16
Sanitation/Hygiene vs Socioeconomic Status	**.35**
Sanitation/Hygiene vs Household Size‡	-.21
Percent of Days Sick with SES	ns
Percent of Days Sick with Sanitation/Hygiene	ns
Percent of Days Sick with Household Size	ns
Percent of Days Sick with Average Kcal/Kg	ns

* All coefficients shown are significant at p .<05. Those in boldface are significant at p <.001.

† Square root of number of persons in the household

‡ Slope of the line regressing weight on age

Growth, defined as the slope of the line describing weight over the study period, was unrelated to average food intake, average food intake/kg, or to any morbidity variable. It was, however, positively and significantly related to household size; ie., children in larger households had better growth.

The sanitation and hygiene score was related positively and significantly to average weight and height Z-scores; that is, taller children came from households with better sanitation/hygiene scores. Sanitation score was related to socioeconomic status (SES)and to household size with lower SES and larger household size related to poorer sanitation scores. Morbidity variables (percent of days ill, percent of days with diarrhea and percent of days with respiratory illness) were unrelated to SES, household size, sanitation score, or average energy intakes.

Since food intake measures were scheduled independently of illness episodes, we may expect that the food intake data fairly represent intake on sick days as well as on well days. To check this assumption, we compared the percent of days

sick and percent of days well in which food intake data were collected (see Table 5.16). There was no difference; almost 5% of days are represented by food intake, whether sick or well.

Table 5.16.
Days of food intake data by illness, toddlers

	Days Well	Days Sick (any illness)	Total
Days with No Food Intake Data	34,980 (95.3%)	4,496 (95.1%)	39,476 (95.2%)
Days with Food Intake Data	1,742 (4.7%)	231 (4.9%)	1,973 (4.8%)
Total	36,722 (88.6%)	4,727 (11.4%)	41,449 (100%)

Chi-square = 0.19, p = .66

The relationship of severity of illness to food intake and to other variables was explored in an analysis which compared characteristics of toddlers whose diarrhea or upper respiratory illness was uncomplicated versus those with the same diagnosis who in the same episode developed dehydration or fever (in the case of diarrhea) or lower respiratory infection (in the case of URI's). Table 5.17 displays the comparison. Socioeconomic status, sex, and household size were similar for those children with milder illnesses and those whose illnesses became more severe. Average energy intake over the preceding three months was also not different. Weight and height (averaged over the previous three months) were not different for the two classes of respiratory illness, but was significantly different for diarrheal disease; those children with more severe illness were lighter and shorter than those whose diarrheal illness was milder. Discriminant function analyses using average energy intake, average weight, and average height over the preceding three months, socioeconomic status, sex, household size, and age, correctly classified only 59.7% of respiratory illness and 62.7% of diarrheal disease as progressive.

Table 5.17.
Characteristics of children whose last episode of respiratory or diarrheal disease was uncomplicated vs. those with progressively severe illness

	Uncomplicated (N = 21)	Upper Respiratory Illness Progressing to Lower Respiratory Illness (N = 31)	t
Average Kcal preceding 3 mos	1280 ± 545	1206 ± 501	0.56
Average Weight (kg) preceding 3 mos	11.4 ± 1.2	11.2 ± 1.7	0.52
Average Length (cm) preceding 3 mos	80.1 ± 3.4	80.1 ± 4.5	0.00
Average Age (yrs) preceding 3 mos	2.2 ± 0.3	2.1 ± 0.3	0.52
Socioeconomic Status Scores	3.03 ± .75	3.03 ± .98	0.00
Sex (1 = M, 2 = F)	1.4 ± 0.5	1.5 ± 0.5	1.01
HH Size (persons)	7.9 ± 2.3	7.0 ± 2.1	1.56

	Uncomplicated (N = 51)	Diarrheal Illness Developed Fever or Dehydration (N = 32)	t
Average Kcal preceding 3 mos	1102 ± 462	1045 ± 389	0.58
Average Weight (kg) preceding 3 mos	11.0 ± 1.4	10.1 ± 1.6	2.53*
Average Length (cm) preceding 3 mos	79.5 ± 3.9	77.5 ± 4.8	2.01*
Average Age (yrs) preceding 3 mos	2.0 ± 0.3	1.9 ± 0.3	1.20
Socioeconomic Status Scores	2.8 ± 1.0	2.9 ± 1.0	0.66
Sex (1 = M, 2 = F)	1.5 ± 0.5	1.6 ± 0.5	0.81
HH Size (persons)	7.9 ± 2.9	6.9 ± 2.2	1.33

* $p < .01$

E. Analytical Models Predicting Weight

The variety of multivariate approaches which were explored in analysis of the dataset is described in the statistical portion of this report. Here we will present results based on the most recent and concise set of analyses. The models start with the existence of a weight measure at "time 2", defined as any month for which there were food intake data in the previous month. Monthly values are defined using a "fuzzy window" of ± 15 days.

We have shown in the previous descriptive section that individual toddlers entered the study at age 18 months with considerable variability in their attained weight. To account for this "individual effect", a subject variable was entered into

the model as ID number nested within sex. Other factors known to systematically influence weight are sex, age, and time of year. Since previous models had shown that there was no nonlinear component of the age effect on weight, the 11-degree-of-freedom variable "Age in Months" was replaced in the model with a variable which described the linear effect of age and used only a single degree of freedom. Time of year was represented by the calendar month.

The above variables were entered first; then the model was sequentially built to test the effects of other variables. Since sex, age, size at entry to the study, and time of year together predicted 88 percent of the variance, it was clear that the impact of other variables was going to be quantitatively minor. The following results indicate effects of relatively small magnitude; however, the potential cumulative effects on weight must be considered in interpreting their importance.

Table 5.18 begins with the analysis of variance data from the model incorporating the variables mentioned above plus breast-feeding status (weaned or partially breastfed in the previous month) and a breast-feeding x sex interaction term. Neither significantly added to the prediction, and the R^2 remained at 0.88.

The next step was to add food intake into the model. Breast-feeding status then became significant; food intake in the previous month did not contribute significantly. The R^2 for the overall model is .89. The addition of a lagged morbidity variable (percent days in the previous month ill with diarrhea) the R^2 for the model improved to 0.90.

Table 5.18.
General linear models predicting weight of toddlers

I. Without Food Intake (816 observations)

Variable	df	Type I Sums of Squares	F	p
Sex	1	84.0	220.0	<.0001
ID(Sex)	130	1380.1	27.8	<.0001
Linear Effect of Age	1	444.5	1164.7	<.0001
Month of the Year	11	38.6	9.2	<.0001
Breast-feeding Status (yes, no)	1	1.0	2.6	ns
Sex vs. Breast-feeding Interaction	1	0.03	0.1	ns

R^2 = .88
Root Mean Square Error = .62
Coefficient of Variation = 5.6%

Parameter Estimates (± SE of Estimate):
Linear Effect of Age: .23 ± .01 kg

Table 5.18 continued

II. With Food Intake (575 observations)

Variable	df	Type I Sums of Squares	F	p
Sex	1	53.3	144.4	<.0001
ID(Sex)	125	963.7	20.9	<.0001
Linear Effect of Age	1	240.4	649.2	<.0001
Month of the Year	11	30.3	7.4	<.0001
Breast feeding Status (yes, no)	1	2.0	5.4	<.05
Sex vs. Breast feeding Interaction	1	0.4	0.9	ns
Kcals/day in Previous Month	1	1.0	2.4	ns

R^2 = .89
Root Mean Square Error = .61
Coefficient of Variation = 5.4%

Parameter Estimates (± SE of Estimate):
Linear Effect of Age: .23 ± .01 kg
Kcal/day in Previous Month: 0.0001 ± .0001 kg

III. With Food Intake and Percent of Days with Diarrhea in Previous Month (551 observations)

Variable	df	Type I Sums of Squares	F	p
Sex	1	43.2	133.0	<.0001
ID(Sex)	121	936.5	23.8	<.0001
Linear Effect of Age	1	235.0	719.2	<.0001
Month of the Year	11	26.0	7.2	<.0001
Breast feeding Status (yes, no)	1	2.4	7.4	<.01
Sex vs. Breast feeding Interaction	1	0.3	1.0	ns
Kcals/day in Previous Month	1	0.8	2.5	ns
Percent of Days in Previous Month with Diarrhea	1	0.5	1.5	ns

R^2 = .90
Root Mean Square Error = .57
Coefficient of Variation = 5.1%

Parameter Estimates (± SE of Estimate):
Linear Effect of Age: .24 ± .01 kg
Kcal/day in Previous Month: .0001 ± .0001 kg
Diarrhea in Previous Month: -.32 ± .26 kg

F. Models Predicting Length and Weight-For-Length

Table 5.19 presents the analysis of variance results from the best models predicting length and length Z-score. As previously described, the slope of gain in length was different for girls than for boys, with girls growing slightly faster. This is reflected in the highly significant predictive value of sex even when the sex-adjusted Z-score is the dependent variable, and in the retention of significant age by sex interaction terms in both models. The time of year influence on length has been described; it is significant in both models. In the Z-score model, time of year is represented by mathematical functions of the time of year. Both models have R^2 values of 0.92; neither food intake variables nor morbidity variables added significantly to the models.

Table 5.19.
General linear models predicting length of toddlers

I. Best Model Predicting Length

Variable	df	Type I Sums of Squares	F	p
Sex	1	307.6	169.3	<.0001
ID(Sex)	146	9713.4	36.6	<.0001
Age in months	11	4255.5	212.9	<.0001
Age by Sex Interaction	11	55.4	2.8	<.01
Month of the Year	11	35.9	1.8	<.05
R^2 =	.92			
Root Mean Square Error =	1.35			
Coefficient of Variation =	1.7%			

II. Best Model Predicting Length Z-scores

Variable	df	Type I Sums of Squares	F	p
Sex	1	307.6	167.5	<.0001
ID(Sex)	146	9718.4	36.3	<.0001
Linear effect of Age	1	4231.1	2304.2	<.0001
Linear effect of Age by Sex	1	21.6	11.8	<.001
Sin term of Season	1	1.8	1.0	ns
Cosin term of Season	1	26.3	14.3	<.001
R^2 =	.92			
Root Mean Square Error =	1.35			
Coefficient of Variation =	1.7%			

Table 5.20 shows predictive model for weight-for-length and weight-for-length Z-score. R^2 values are lower than those for the models predicting weight and length, .80 and .67 respectively. The effect of sex is small, though significant; individual effects accounted for the largest share of the variance, with age and time of year contributing small but significant components. Neither food intake nor morbidity variables added significantly.

Table 5.20.
General linear models predicting weight-for-length

I. Best Model Predicting Weight-for-Length

Variable	df	Type I Sums of Squares	F	p
Sex	1	.01	116.8	<.0001
ID(Sex)	145	.12	14.7	<.0001
Age in months	11	.02	36.5	<.0001
Month of the Year	11	.01	9.4	<.0001
R^2 =	.81			
Root Mean Square Error =	.008			
Coefficient of Variation =	5.5%			

II. Best Model Predicting Weight-for-Length Z-scores

Variable	df	Type I Sums of Squares	F	p
ID	146	579.6	8.7	<.0001
Linear Effect of Age	1	10.4	22.8	<.0001
Sin Term of Season	1	21.0	45.8	<.0001
Cosin Term of Season	1	12.7	27.8	<.0001
R^2 =	.67			
Root Mean Square Error =	.68			
Coefficient of Variation =	460.7%			

G. Models Predicting Morbidity

We have used the same general approach to the prediction of morbidity variables, and find that the variables with which we are working predict only about 25 percent of the variance in days ill; whether we look at total days ill, days ill without skin ailments (which are of relatively long duration but low severity), days with diarrhea, or days with respiratory illness (see Table 5.21). Individual effects, age, and season were the only significant contributors to the models; lagged food intake variables did not add any significant information. The relatively small R^2 values and large coefficients of variation indicate to us that other analytic approaches may be called for. If food intake has an effect, it is through variables not examined in these analyses.

We emphasize the preliminary nature of these analyses. Previous analyses using the projects food composition database for calculation of energy intake resulted in models for body weight in which food intake had a significant effect. The use of Atwater factors to estimate food energy may have simply introduced enough "noise" to eliminate an effect. Further analytical efforts are obviously called for after the food composition database has been finally revised.

Table 5.21.
General linear models predicting morbidity variables

I. Dependent Variable: Percent of Days Ill

Variable	df	Type I Sums of Squares	F	p
ID	148	12.0	2.8	<.0001
Month of the Year	11	1.4	4.5	<.0001
Age in Months	11	0.3	1.1	ns

R^2 = .25
Root Mean Square Error = .17
Coefficient of Variation = 152%

II. Dependent Variable: Percent of Days Ill Excluding Skin Ailment

Variable	df	Type I Sums of Squares	F	p
ID	148	10.5	2.9	<.0001
Month of the Year	11	1.3	4.9	<.0001
Age in Months	11	0.4	1.4	ns

R^2 = .26
Root Mean Square Error = .16
Coefficient of Variation = 166%

III. Dependent Variable: Percent of days Ill with Diarrhea

Variable	df	Type I Sums of Squares	F	p
ID	148	3.3	2.4	<.0001
Month of the Year	11	0.9	9.2	<.0001
Age in Months	11	2.0	1.9	<.05

R^2 = .25
Root Mean Square Error = .096
Coefficient of Variation = 263%

Table 5.21. continued

IV. Dependent Variables: Percent of Days Ill with Respiratory Illness

Variable	df	Type I Sums of Squares	F	p
ID	148	3.1	2.1	<.0001
Month of the Year	11	0.6	5.3	<.0001
Age in Months	11	0.1	1.1	ns

R^2 = .21
Root Mean Square Error = .100
Coefficient of Variation = 282%

H. Cognition and Behavior of Toddlers

1. Descriptive Statistics

The descriptive statistics for the toddlers performance on the Bayley Mental Scale, Bayley Motor Scale, Uzgiris-Hunt Subscales, Toy Play Codes, and Infant Behavior Record are shown in Table 5.22. The data shown in Table 5.22 indicate that, for the Bayley Mental Scale, although the raw scores are below US norms, there is a steady increase in Bayley raw scores over age levels, as would be expected. A similar increase is shown for the Means and Foresight subscales of the Uzgiris-Hunt. However, the object permanence subscale of the Uzgiris-Hunt shows little change from 18 to 24 months. This cannot be attributed to a ceiling effect, since the mean number of items passed is well below the ceiling for this scale. These results suggest limited change in the development of recall memory for Egyptian toddlers between 18-24 months.

For toy play a decrease in manipulative and exploratory play and an increase in relational, functional and symbolic play, from 18 to 30 months were expected. However, as shown in Table 5.22, little age change in the toy play codes is shown across the three age periods. The overwhelming majority of Egyptian toddlers toy play behaviors involve simple manipulation of objects.

In terms of the Infant Behavior Record within the Egyptian sample there appear to be no systematic age changes in person or examiner responsivity, cooperativeness, tension, reactivity, energy, or gross motor coordination. There was a sharp increase in cooperativeness from 24 to 30 months for this sample and a decrease in fearfulness after 18 months. There was also some decrease in activity after 18 months as well. As might be expected there is a slow increase in fine motor coordination from 18 to 30 months (lower scores mean better coordination). The scores for responsivity to examiner, attention and activity level appear to be congruent with scores obtained by US toddlers of the same age. The Egyptian sample is higher then U.S. norm in cooperativeness at ages 18 and 24 months but not at age 30. The Egyptian sample is higher in fear at age 18 months, but is relatively congruent with US norms at 24 and 30 months. Similarly, the Egyptian sample is at the US level in person responsivity at 18 to 24 months, but is clearly lower in responsivity at 30 months. Reactivity clearly is lower in the Egyptian sample at all age levels.

In terms of sex differences, there is little evidence for sex differences on the Bayley Scores, or on the three Uzgiris-Hunt Subscales. On the toy play measure, males show consistently more functional play at 18 - 30 months than females (males: 18 months 10%, 24 months 11%, 30 months 12%; females 18 months 7%, 24 months 8%, 30 months 8%). Although there are few differences at 18 and 24 months, males show more exploratory behavior at 30 months (males 11%, female 6%). In contrast, females consistently show more social interactions in their toy play from 18 through 30 months (males 18 months 8%, 24 months 12%, 30 months 7%; females 18 months 20%, 24 months 13%, 30 months 12%). Similarly, females show more nonresponsive behavior to toys at 30 months (males 0%, females 4%).

For the IBR again there are few observed sex differences, except on two subscales. Specifically males show more fear at 18 months (males 5.17, females 3.64). Males are consistently higher in activity from 18 to 30 months (males 18 months 5.46, 24 months 5.14, 30 months 5.42; females 18 months 4.48, 24 months 4.41, 36 months 4.16). These differences in toy play behavior, on functional and social behaviors, as well as the IBR activity differences are congruent with what has been previously reported in the US literature in terms of sex differences.

Comparisons were also made between breast fed and non breast fed toddlers at 18 and 24 months (there were no breast fed toddlers at 30 months). The only noticeable differences between the groups were on the Toy Play and IBR measures. For the toy play, the breast fed children at 24 months showed more exploration, more manipulation, and less relational and social play. That is, breast fed children at 24 months showed more lower level play behavior and less higher level play behavior. However, the generalizability of these results must be severely restricted given the very small number of breast fed babies at 24 months (n = 4 babies). Similarly, on the IBR, breast fed babies showed higher person responsivity at 24 months and lower cooperativeness at 24 months. Again, these differences must be qualified, based on the fact that the sample size was only two infants.

Table 5.22.
Mean cognitive and cognitively related performance of total sample of Egyptian toddlers at 3 age levels

Measure	Age 18	24	30
Bayley Mental			
(# items passed)	126.97	138.59	146.42
Bayley Motor	Na	Na	Na
Object permanence			
(# items passed)	11.13	11.65	Na
Objects as means	7.92	8.80	Na
Foresight			
(# items passed)	3.51	4.26	Na
Toy Play: (%)			
manipulative play	.53	.53	.54
Exploration	.10	.09	.09
Relational play	.11	.10	.13
Functional play	.08	.09	.10
Symbolic play	.01	.02	.01
Social play	.12	.12	.09
No play behavior	.02	.02	.02
Infant Behavior Record:			
(raw score)			
Person responsivity	5.36	5.71	5.57
Examiner responsivity	3.46	3.32	3.75
Cooperativeness	5.78	5.32	6.38
Fearfulness	4.58	2.61	2.48
Tension	3.67	3.23	3.18
Activity	4.97	4.78	4.79
Reactivity	5.23	5.52	5.64
Energy	3.16	3.20	3.26
Gross motor coordination	2.84	2.61	2.60
Fine motor coordination	2.79	2.66	2.48

Na - data collected but not accepted as usable for analysis; further error checking in progress.

The descriptive statistics for the observational scores, encompassing both ecological setting, caregiver behaviors towards child and child environment interactions are shown in Table 5.23.

Results shown in Table 5.23 indicate little change across this 12 month period in the number of persons within 5 feet of the child (a measuring of crowding), number of vocalizations directed to the child, parental nonresponse to the child's vocalization, amount of nonresponse to the child's distress, and the number of vocalizations emitted by the child. Across this 12 month period there is a decline in the amount of time the mother or the caregiver is within reach of the child, the amount of time the child is either in an irritable or a sleepy state, amount of time the child is inside the home, amount and duration of physical contact, amount of nonverbal response to the child's vocalization, the time of parental response to distress, and the amount of distress shown by the child. In contrast, over 12 months there is an increase in the amount of social and object involvement shown by the child, the amount of time the child is in active alert state, the amount of time the child's location is outside of the home, the amount of verbal response to the child's vocalization, and the amount of time there is no designated caregiver near the child.

In terms of sex differences, the results indicate a slower increase for both social and object involvement for females from 18 through 30 months (male social involvement went from 49% to 61% from 18 to 30 months, while female social involvement went from only 505 to 53% during this time period; similarly, male object involvement went from 45% to 57% while female object involvement went from 45% to 49%). This may be in part be related to sex differences in location, in that males showed a sharp increase in the amount of outside the home time (20% to 32%), while female showed little increase (20% to 22%) between 18 - 30 months. The difference in location may also reflect the fact that males showed a relatively sharper decline in the percent of time there was an adult caregiver close to the child (male child 78% to 70%) as opposed to very little decline for females (81% to 79%) from 18 - 30 months. Finally, the number of child vocalizations between 18 and 30 months indicated a decline in the number of vocalizations for males (10.74 to 2.74) and an increase for females (8.27 to 9.10).

Table 5.23.
Observational database for Egyptian toddlers and their caregivers

	Toddler ages	
Behavioral category	18-23 months	24-30 months
# persons near toddler per session	3.98	3.62
% time mother within reach of child per session	79	56
% time other caregiver within reach per session	88	71
% time adult caregiver per session	79	72
% time sib caregiver per session	17	18
% time no caregiver per session	3	10
% time child in specific locations per session		
Own home - inside room	41	28
Own home - courtyard	37	43
Neighbors - inside room	00	00
Neighbors - courtyard	00	00
Outside - near own home	20	27
Outside - near street	00	00
Outside - far street	00	00
Outside - fields	00	00
Outside - Clinic	00	00
% time child involved with persons per session	49	57
% time child involved with objects per session	45	53
% time child in behavioral state per session		
irritable	01	01
active-alert	93	99
passive	03	01
sleepy	01	00
Total # of physical contacts with child (cross six month time block)	646.31	247.45
Average duration of physical contact with child (in seconds)	317.73	84.54

Table 5.23. continued

Behavioral category	Toddler ages 18-23 months	24-30 months
Total # of physical contacts where adult not doing other activities	319.54	48.44
# child vocalizations per sessions	8.70	8.89
# spontaneous adult vocalizations to child per session	10.24	12.49
% child vocalizations per sessions not responded to	27	25
% child vocalizations per session responded to physically	29	23
% child vocalizations per session responded to verbally	36	46
# incidents child distress per session	.27	.16
% incidents child distress not responded to per session	02	02
Average adult response time to distress (seconds) per session	110.71	87.30
% ineffective response to child distress per session	06	02

2. Relation of Food Intake to Outcome: Do higher levels of food intake relate to higher levels of cognitive performance and more optimal behavioral patterns?

Food intake, expressed as both total kcals of intake and kcals per kilogram of intake from 18 to 23 and from 24 to 29 months were correlated with the cognitive and observational outcome measures described earlier. Five percent of the correlations between food intake and outcome were statistically significant. These significant correlations are shown in Table 5.24.

Although the correlations between food intake and outcome are sparse, the directionality of these correlations are generally consistent with the hypotheses noted above. Specifically, higher levels of food intake between 18 and 23 months are positively associated with more person involvement, object involvement, and amount of language shown by the toddler during this period. Similarly, higher levels of food intake between 18 and 23 months are also positively related to Bayley Mental Performance, as well as reactivity, as scored on the Infant Behavior Record, and amount of functional play shown by the toddler at 30 months of age. The only results inconsistent with the hypotheses described above are shown in regard to measures of the child's location (a proxy for activity level), with results indicating that more time spent inside the home from 24 to 29 months (low activity) is negatively associated with intake during this time period (as would be predicted), but is positively associated with intake from 18 to 23 months. The negative correlation between location outside the home (high activity) from 18 to 23 months and food intake from 24 to 29 months may suggest that more active toddlers are less often available to be fed by caregivers.

Table 5.24.
Significant correlations between food intake and cognitive and behavioral outcome parameters

Outcome	Food intake Kcal 18-23 Months	Kcal 24-29 Months	Kcal/Kg 18-23 Months	Kcal/Kg 24-29 Months
Bayley Mental - 30 Months	.36*			
IBR-reactivity-30 Months	.29*			
Functional Play - 30 Months	.32*		.37†	
Person Involvement 18-23 Months	.25†			
Object Involvement 18-23 Months	.20*			
Amount child vocalization 18-23 Months	.25†		.21*	
Child location-Outside home 18-23 Months				-.24*
Child location inside home 24-29 Months			.19*	-.24*

* $p<0.05$
† $p<0.01$

While the above data would indicate some relation between food intake and outcome, the meaning of the results shown in Table 5.24 must be considered in terms of other potential influences on outcome variables, which may covary with intake. Specifically, although analyses of our toddlers data indicates no relation between food intake and either morbidity or anthropometry, there were a number of significant correlations between food intake and quality of the toddlers' rearing environment (6% of the matrix significant). Summarizing this data, our results suggest that lower levels of food intake are associated with more caregiving by sibs rather than adults and by higher use of physical contact stimulation. Higher levels of toddler food intake are associated with more nonresponsivity to toddlers vocalization and lower levels of nonverbal and verbal responsivity by caregivers to the toddlers vocalizations. To the extent that the rearing environment is associated with outcome measures (as will be shown below), these results suggest that the impact of food intake upon toddler outcome can not be considered in isolation from the quality of the toddlers' rearing environment.

3. Anthropometry and Outcome: Do heavier and/or taller children have higher levels of cognitive performance and more optimal behavioral patterns?

Results indicate that 6% of the correlational matrix for anthropometry was significant. These data are shown in Table 5.25. The results shown in Table 5.25 indicate a consistent relation between height and Bayley mental development scores, with height at both 18 and 30 months being positively related to the level of mental development at these same ages. There was no consistent relation between anthropometric indices and performance on the IPDS. In terms of the Infant Behavior Record, for those IBR scales that could be reliably scored, weight at 24 months was positively related to the child's person responsiveness, while negatively related to examiner responsivity during the same age period. This pattern suggests that heavier children are more comfortable with familiar persons but have a greater fear of strangers than children who are lower in weight. The above results also indicate that height at 30 months was positively related to person responsiveness at 30 months. Anthropometric measures were generally unrelated to toy play behavior.

Table 5.25.
Significant correlations between anthropometry and cognitive and behavioral outcome parameters

Outcome	Anthropometry			
	Weight 24M	Weight 30M	Height 24M	Height 30M
IBR - Person				
Responsiveness - 24M	.38*			
IBR - Examiner				
Responsiveness - 24M	-.37			
IBR - Person				
Responsiveness - 30M				.34*
Symbolic Toy Play - 24M	-.40*			
Person Involvement				
18 - 23M		-.38*		
Object Involvement				
18 - 23M	-.37*	-.49*		
Object Involvement				
24M - 29M		-.42*		
Amount Distress 24M - 29M		.34*		
Amount Vocalization 24M - 29M		-.32*		

* $p<.05$

In terms of the relation between anthropometric variables and behavior, the results again support the existence of a bi-directional effect between child behavior and physical indices. Specifically, the results indicate that children who are less person and less object involved from 18 to 23 months weigh more at 24 months; similarly, children who are less object involved from 24 to 29 months show higher weights at 30 months. These results may be due to a heavier child being more passive than a leaner child. Interestingly, children who are more distressed from 24 to 29 months also are found to weigh more at 30 months. In addition, children who are less vocal from 18 to 23 months weigh less at 30 months.

4. Relations of Morbidity to Outcome: Do Children with higher levels of morbidity, have lower levels of cognitive performance and less optimal behavioral patterns?

Relations between morbidity and outcome were generally scattered and inconsistent. Overall, only 5 % of the matrix was found to be statistically significant. These data are shown in Table 5.26. In general, morbidity was unrelated to cognitive performance, though there was a negative relation between the number of sick days between 18 and 23 months and Bayley MDI performance at 24 months. Similarly, there was little relationship between toy play and morbidity. The most consistent relations are found with the behavioral outcome data, with results indicating that morbidity (whether defined as total amount of morbidity or in terms of a specific illness) is associated with children being less often in an active alert state and more often in a passive state. These results are also consistent with the significant relations found for the IBR, which indicate that diarrhea from 24 through 29 months is negatively related to IBR person responsivity at 30 months. In interpreting these data, it must be emphasized that neither observations nor tests were done at a time when the child was acutely ill.

Table 5.26.
Significant correlations between morbidity and cognitive and behavioral outcome parameters

	Morbidity							
	# sick days		# non-skin sick days		Respiratory		Diarrhea	
Outcome	18-23	24-29	18-23	24-29	18-23	24-29	18-23	24-29
Bayley MDI-24	-.28*							
IBR-Person Responsiveness-24							.25*	
IBR-tension-24			.25*					
IBR Person Responsiveness-30								-.31*
Exploratory Play-24	.28*							
Functional Play-30								.32*
Object Involvement 18-23			.23*					
Active Alert State 24-29		-.35†		-.34†		-.21*		-.26†
Passive State 24-29		.42†		.41†		.32†		.40†

* p<.05
† p<.01

5. Interaction Variables and Outcome: Do characteristics of the child's rearing environment relate to level of cognitive performance and behavioral patterns?

Intercorrelations between measures of the child's environment and the cognitive, play, and temperament measures are sparse and inconsistent (approximately 4.5% of the matrix was statistically significant). These results are shown in Table 5.27. Results shown in Table 5.27 indicate little relation between environmental measures and 24 month Bayley. However, there are a number of relations found between environment and 30 month Bayley, with the direction of these relations being consistent with data reported in the United States. Specifically, 30 month Bayley is found to be negatively related to the number of persons close to the child between 18 and 23 months (a measure of crowding) and positively related to the mother within reach of the child between 24 and 29 months. There was also a trend for the number of vocalizations to the child to be positively related to 30 month Bayley Mental Scale ($r = .26$ $.10 > p > .05$).

Table 5.27.
Significant correlation between environmental factors and cognitive, exploration, and IBR outcome parameters

	Outcome parameters				
Environmental factors	Bayley MDI-24	Bayley MDI-30	IPDS Permanence-24	IPDS Foresight-24	IPDS Means-24
# persons 18-23		-.49†	.40*		.30*
Sib caregivers 24-29					-.34†
No caregivers 28-23			-.26*		
No caregivers 24-29					.38*
Caregivers within reach 18-23			.38†		.34†

Table 5.27. continued

Environmental factors	Outcome parameters: Bayley MDI-24	Bayley MDI-30	IPDS Permanence-24	IPDS Foresight-24	IPDS Means-24
Caregivers within reach 24-29			.28*		
Mother within reach 18-23			.30*		.30*
Mother within reach 24-29		.36*			
Amount physical contact 18-23			.35*		.32*
Contact only 18-23			.36†		
Contact only 24-29			.28*		
# vocalizations 18-23					-.48†
No response to vocalizations 18-23			.30*	-.37†	
No response to vocalizations 24-29			-.34*		.42†
Non verbal response to vocalizations 18-23				.27*	
Non verbal response to vocalizations 24-29			-.28*	-.28*	
Verbal response to vocalizations 24-29					-.32*
No response to distress 18-23					-.28*
No response to distress 24-29	-.25*				
Effectiveness response to distress 18-23					
Effectiveness response to distress 24-29	-.30*				.35*

	Simple Manipulative Play-24	Exploration-24	Relational Play-24	Symbolic Play-24
# persons 18-23			.31*	
Contact only 18-23	.29*			
No response to vocalizations 18-23		.29*		
Effectiveness response to distress 18-23				.29*

Table 5.27. continued

Environmental factors	IBR Person Responsiveness	IBR Fear 30	IBR Tension 30	IBR Reactivity 30	Exploration 30	Social Play 30
Adult caregivers 24-29	-.34*	-.29*	.47†			
No caregivers 24-29	.34*	-.27*	.32*			
Contact only 24-29	-.29*					
# vocalizations 24-29						.32*
No response to vocalizations 24-29				.32*		
Non verbal response to vocalizations 24-29			.28*			
Effectiveness response to distress 24-29	-.28*	.27*		-.28*	.40†	

* p<.05
† p<.01

While object permanence was found to be highly related to environmental variables, the directionality of the relationships was surprising in a number of instances. Specifically, consistent with previous research, the degree to which the caregiver or the mother were in reach of the child between 18 and 23 months was positively related to object permanence at 24 months, while object permanence at 24 months was negatively related to the amount of time there was no caregiver near the child. However, surprisingly, 24 month object permanence was also found to be positively related to the number of persons between 18 and 23 months, positively related to physical contact variables during this time, and positively related to nonresponse to vocalization between 18 and 23 months. These latter results were surprising in that US data has consistently shown that crowding is negatively related, physical contact is positively related only in the first year of life and nonresponse to vocalizations are negatively related to cognitive outcomes. A similar situation is shown with the Development of Means. Consistent with earlier research, both mother and caregiver within reach between 18 and 23 months are positively related to Means performance at 24 months. Similarly, the effectiveness of response to the child's distress from 18 to 23 months (a measure of caregiver sensitivity) is positively related to Means at 24 months, while the degree of nonresponse of the child's distress between 18 and 23 months is negatively related to 24 months Means. However, paradoxically, 24 month Means is found to be positively related to the number of persons, positively related to amount of physical contact, negatively related to number of vocalizations and negatively related to the amount of verbal responsivity to the child's vocalizations between 18 and 23 months.

For the Infant Behavior Record environmental variables are unrelated to Infant Behavior Records at 24 months. The results shown do indicate that the level of fear shown during testing at 30 months is negatively related to the number of adult caregivers and to the number of times the child does not have a specific caregiver from 24 through 29 months. Tension at 30 months is positively related to the number of adult caregivers, but is also positively related to the lack of a designated caregiver from 24 through 29 months. Tension is also positively related to nonverbal response to child's vocalization between 24 and 29 months. Reactivity is found to be positively related to response to vocalization and negatively related to effectiveness of response to distress from 24 through 29 months. The above results also indicate that the number of adult caretakers between 24 and 30 months is negatively related to person responsivity at 30 months, while lack of designated caregiver is positively related. The amount of physical contact between 24 and 29 months is negatively related to person responsivity at 30 months, as is effective response to distress. The relation between environmental characteristics and toy play behavior were generally scattered and inconsistent.

The most consistent relations are shown between environmental characteristics and behavioral outcomes for toddlers (10.8% of this matrix was significant). Because of the large and complex pattern of results, only the most consistent relations will be summarized in the text. Specifically, the results relating rearing environment to toddler behavior indicate that four dimensions of the rearing environment appear to be most consistently related to toddler behavior. These are caregiver proximity, amount of tactual kinesthetic stimulation, amount of vocalization directed to the child, and responsivity of the environment to the child. In terms of caregiver proximity, the more often the caregiver is closer to the child, the less likely the toddler is to vocalize, be outside the home (activity), or be showing distress. In terms of tactual kinesthetic stimulation, the more often the child is picked up or handled, the less time the child is found to be involved in objects, the less time the child is found to be in an alert state, and the more often distress is shown. This pattern of results may suggest caregiver responsivity to the child's behavior, rather than the environment influencing the child's development. In terms of caregiver vocalization, congruent with data from the United States, the more often caregivers vocalize to the child, the more often the child is involved with both persons and objects in its environment, the more often the child is found to be an alert state, and the more vocalizations are emitted by the child. In terms of responsivity, again the results are congruent with data from the United States. Specifically, the more often caregivers are responsive either to the child's vocalization or to the child's distress, the more the child is found to be involved with persons and objects in its environment and the more the child is found to vocalize. Conversely, the less often caregivers are responsive to the child, particularly in terms of distress, the more often the child is found to show distress. It is also worth noting that the results for responsivity also indicate the importance of appropriate responsivity. Specifically, the more often caregivers respond to the child's vocalizations by nonverbal responses, the less vocalization and the less involvement in its environment are shown by the child.

6. Discussion of Findings

In terms of the overall question raised by the CRSP, the project results do indicate a low but consistent relation between food intake and cognitive- behavioral development during the toddler period. However, the nature of the results are quite complex, suggesting that the relation between food intake and toddler development is not a simple one, and perhaps raise more questions then they answer.

As has been repeatedly noted in the literature (Brozek, 1978; Rush 1984) low food intake rarely occurs in isolation. Rather, available evidence indicates that low food intake is part of a system of risk factors, including an increased probability of morbidity and inadequate psychosocial environment. All of these covarying risk factors, both singly and in combination, have the potential to retard development. While the present results indicate no relation between food intake and morbidity, the present results do indicate a relation between food intake and indices of the adequacy of toddlers' psychosocial environment. The fact that measures of food intake and measures of critical environmental factors (ie., responsivity) covary, plus the fact that both food intake and environment predict a common set of outcome variables (Bayley scores, vocabulary, activity) makes it difficult to summarize results with a single statement about the relevance of food intake to outcome. Statistically, it is possible to use partialling techniques to make a statement about unique variance accounted for by specific predictors but, as has been argued (Scarr, 1985), such approaches, while statistically correct, may give an oversimplified few of the phenomenon under study, when risk factors naturally covary. This is particularly true when one is considering future research or when planning interventions. For a multidetermined outcome, one cannot simply focus on just one aspect of the risk system (ie., food intake) and ignore the contribution of other predictor variables. Rather, as will be noted below, it is critical to go beyond univariate causal models to develop multidimensional process models, if we are to be successful both in future research and intervention.

A second aspect of this complexity has to do with the differential relation between predictors and the specific outcome variables used. Specifically, our results indicate that for the IPDS, the only consistent predictors involve environmental variables. For toy play measures, the only consistent predictor is morbidity. The fact that certain predictors appear to be uniquely related only to certain cognitive or behavioral outcome dimensions is not a new finding even in the nutritional literature. Prior research from the Bogotta intervention project (Waber et al., 1981) indicates that nutritional supplementation primarily affects motor development, as compared to educational intervention which appears to uniquely affect early language development. These earlier data, plus the present pattern of results, suggest that the researcher

must specify what aspects of outcome are being considered. Not all aspects of development appear to be influenced by specific predictors.

A third complexity shown in our results has to do with the nature of food intake per se. Traditionally, food intake has been treated primarily as a matter of availability of resources, and to some extent, household or cultural practices. However studies done both in Africa (DeVries, 1984) and in the United States (Carey, 1985) suggest that child characteristics may influence how often or how adequately the child is fed. The present data also illustrate the importance of child characteristics on food intake, in terms of indicating that more active infants receive less caloric intake than inactive infants. These results indicate that focusing just on food intake in isolation, without consideration of child characteristics, may lead to potentially misleading results about the relation of food intake to outcome. For example, if an outcome factor like activity is stable across time, then suggesting a causal relation between food intake and outcome, based on only one time point, may be misleading. This relation at a given point in time may be due less to food intake than to earlier activity influencing both subsequent food intake and later activity.

The necessity for considering child characteristics as potentially determining food intake strongly emphasizes the need for future, longitudinal research in this area, both for research purposes and for intervention. To the extent that food intake is influenced by child characteristics, it is important to map the relation between characteristics and intake across time. Such a longitudinal strategy could not only illustrate the process wherein child characteristics are translated into differences in intake, but could also illustrate how this longitudinal relation ultimately leads to variability in outcome. Similarly, a longitudinal strategy could also be useful for intervention, in terms of telling us which infants are at risk for low caloric intake within a given setting, due to specific characteristics possessed by at-risk children.

A longitudinal research design would also help to answer other questions raised by the present results. For example, our results indicate that morbidity was consistently related to the child's behavioral state, with only tentative relations to cognitive performance. It could be hypothesized that a child who is in a less active, more passive state would, over time, begin to show decrements in cognitive performance due to less involvement within the environment. Thus, over time there may be a relation between morbidity and cognitive performance, mediated by the child's state; this relation would not be revealed except during a longitudinal study relating morbidity to outcome.

Besides emphasizing the need for more longitudinal research, the present results also strongly support the importance of utilizing more complex process analyses to deal with both the multidetermined aspects of development as well as the potential interrelation among predictors, as these influence outcome. While our results suggest some potential unique influences for specific predictors with specific outcomes, for the most part, outcomes appear multidetermined. Given the complexity of potential relations, it seems clear that no single causal model will be adequate to encompass the relation between predictors and outcome, though this assertion is obviously open to empirical test. An example of how more complex analytic models might be used are shown in Figures 5.12 through 5.15. In developing these hypothesized causal models, a distinction was made between measures of performance (the child possesses the specific ability under study but, for a variety of reasons, is prevented from using this ability) versus competence (defined by whether or not the child actually possesses the specific ability under study). Hypothetically, sets of different predictors should relate to performance versus competence outcomes.

Figures 5.12 and 5.13 refer to competence scores (the Bayley Mental Score), with Figure 5.12 being a causal model derived from the Egyptian data set prior to looking at the results presented in this report. Model 2 is an extrapolation from the Kenya data set to Egypt, as a means of determining the degree to which there is cross-country fit. Models 3 and 4 refer to performance measures (child language), with model 3 based on an hypothesized relation between predictors and child language in the Egyptian data set prior to looking at the results. Again, model 4 is a generalization from the Kenya results to Egypt.

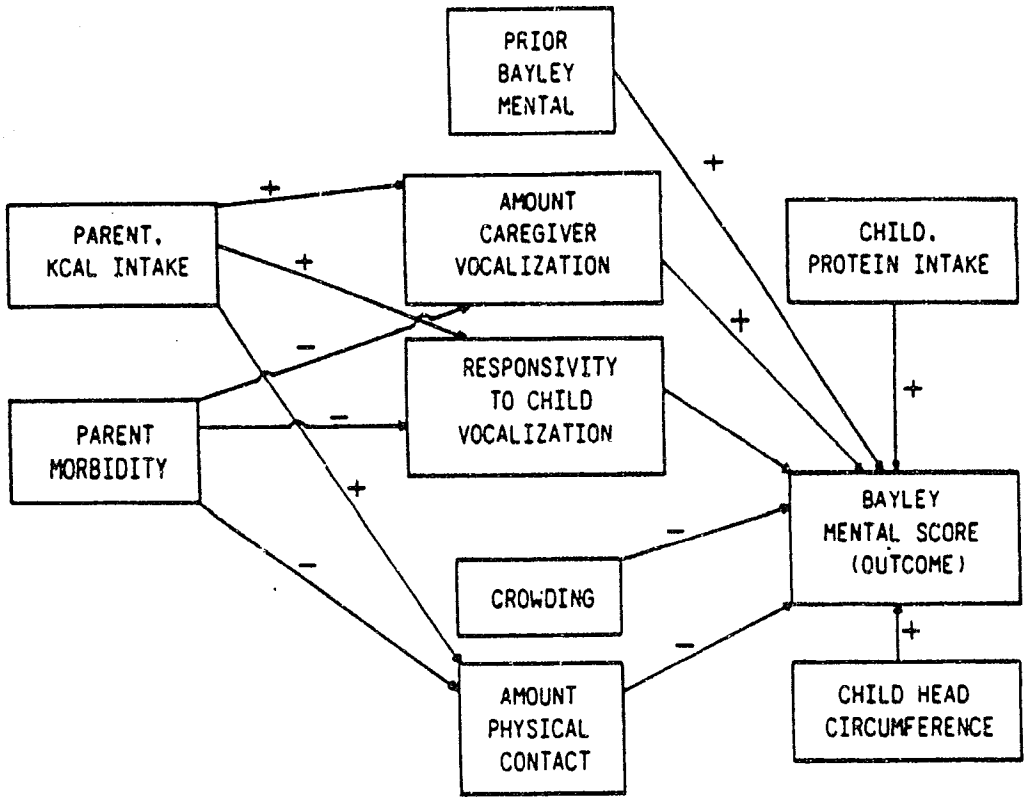


FIG 5.12. Proposed analytic model for Egyptian data set involving Bayley Mental Score (competence) - Model derived from Egyptian data set

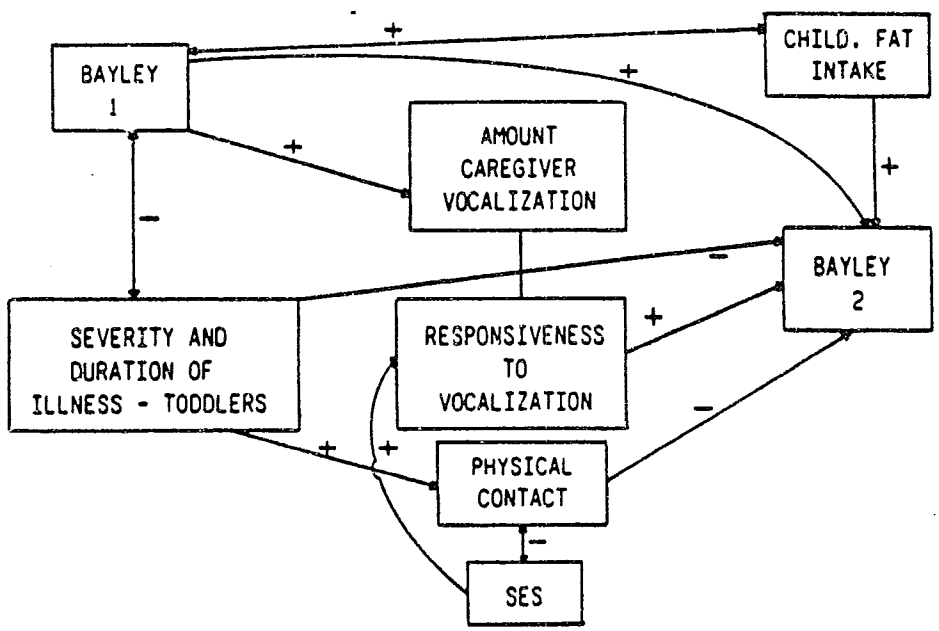


FIG 5.13. Proposed analytic model for Egyptian data set involving Bayley Mental Score (competence) - Model derived from Kenya data set

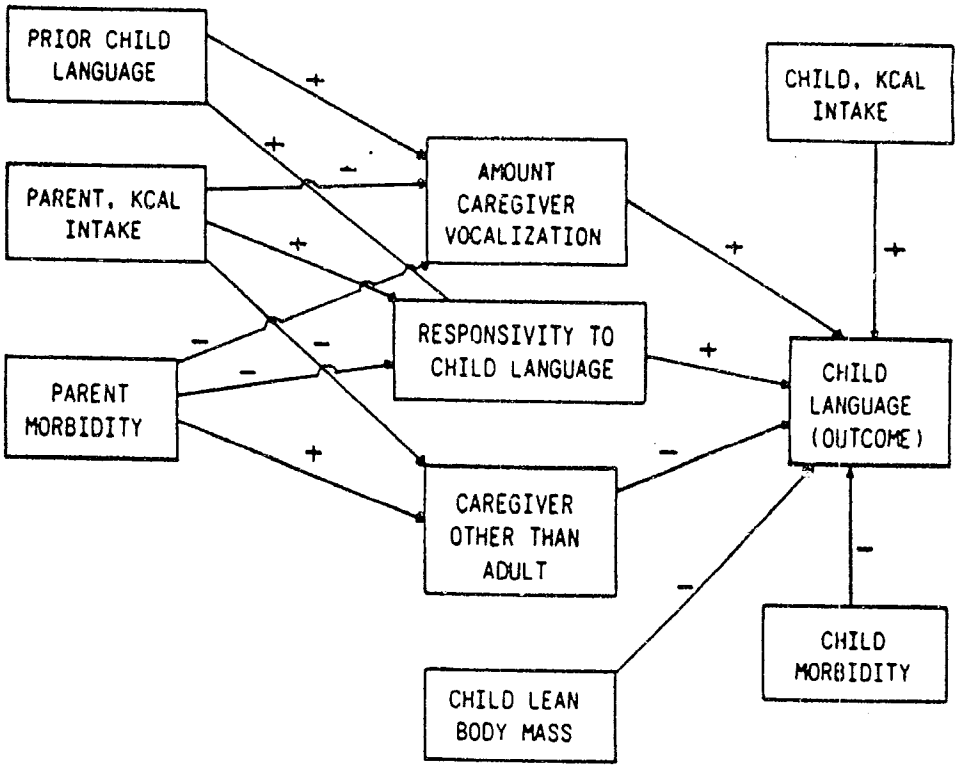


FIG 5.14. Proposed analytic model for Egyptian data set involving child language measures (performance) - Model derived from Egyptian data set

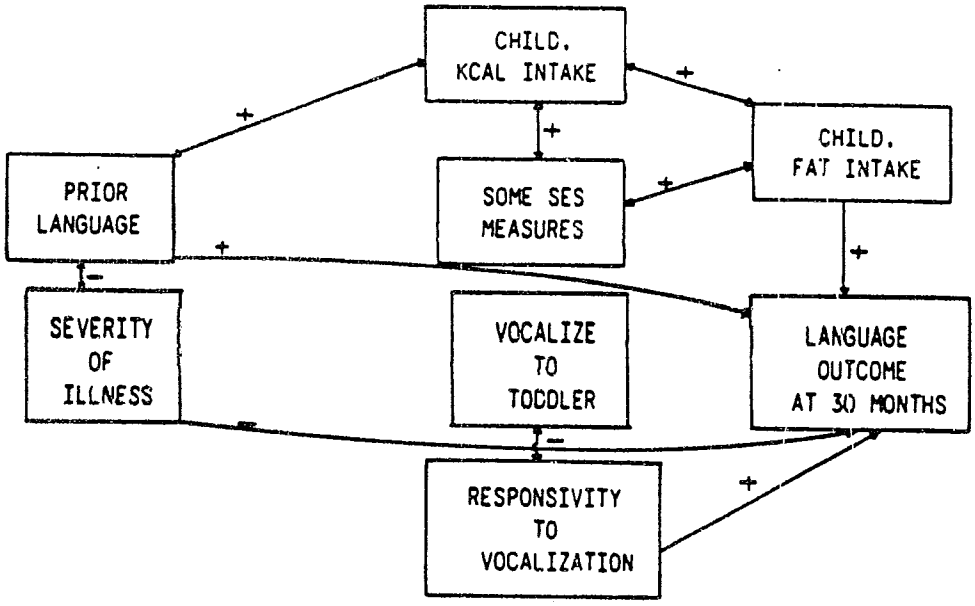


FIG 5.15. Proposed analytic model for Egyptian data set involving child language measures (performance) - Model derived from Kenya data set

The utilization of such conceptual models can be envisioned in two ways. First, there is the question of goodness of fit. That is, to what degree do the observed results actually relate to what has been hypothesized. This would be done by comparing the goodness of fit for models 1 and 3 with the actual results. The results of this type of analyses can be used to determine whether terms need to be added or subtracted to the specific model, as well as specifying how relevant predictors relate both to each other and to outcome.

The models shown in Figures 5.13 and 5.15 can be used to test the generalizability of relations found in Egypt to other cultures. To the extent that the Kenya model fit the Egyptian results tells the researcher the degree to which predictor-outcome relations can or cannot be generalized across cultural contexts. From the data set presented in this report, the present results suggest that cross-cultural generalizability may be somewhat limited. For example, previous research on the relation between child characteristics and child intake in Africa (DeVries, 1984) suggests that in Africa, more irritable children appear to be fed more, whereas the present results suggest that in Egypt no such relation appears. Similarly, comparison of environment development relations between Egypt and the United States suggest that certain factors such as crowding, which are negatively related to development in the United States (Wachs & Gruen, 1982), appear to be unrelated to development in Egypt.

To the extent that results do not generalize across cultures, there are critical implications for both future research and intervention. In terms of research it will be important to specify how cultural differences mediate prediction-outcome relations. For example, there is greater use of sib care and greater population density in Egypt than in the United States. This may lead to either adaptation by the child to crowding in Egypt or to cultural pressures on sibs and other people to help younger children.

In terms of intervention, to the extent that there are valid cross-cultural differences, a simple intervention strategy may be of only limited utility. Rather, specific intervention strategies may need to be tailored for specific cultural contexts to maximize the relevance of interventions for outcome.

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II.. PREGNANCY AND LACTATION OUTCOME

The principal pregnancy-infancy hypothesis of Nutrition CRSP is that food intake during pregnancy/lactation influences the infant's endowment at birth and during the first six months of breast feeding. Also, that maternal food intake affects maternal activities for sanitation and child care, which in turn affect the morbidity and development of the infant. This section describes the study population of pregnant and lactating women and their infants. Retrospective data for prior reproductive outcome and prospective data for food intake, anthropometry, and morbidity experience over the 2nd and 3rd trimesters of pregnancy and the first six months of lactation are shown. Anthropometry, morbidity, and supplementary food intake data of the infant are described from birth to six months of age. Finally, interrelationships among these variables were examined according to the proposed model for pregnancy and lactation outcomes shown in Figure 5.16.

A. Description of Subjects

1. Age and Reproductive History

Descriptive data, whether summarized for 104 pregnant women who comprised the study population (Table 5.28) or for a subset of 63 women for whom longitudinal anthropometry data were available, were remarkably similar. Data for the larger group are described here. Mean age of the pregnant women was 25.9 ± 5.9 years, and most women (57.7%) were between the ages of 20 to 30 years. Among the women who were outside this age range, more women were 30 years or older (27.9%) than were less than 20 years of age (14.4%). The youngest individual in the study was 17 years of age. The mean birth interval of these women was 29.5 ± 9.9 months and most (60%) were between 18 and 30 months. One-third (33.6%) of the women had birth intervals of 30 months or greater, and only 6% had intervals of less than 18 months. Mean parity was 4.0 ± 2.8 and only 8% of the study population was primigravid. Almost one-half (49%) of the women reported four or more pregnancies prior to the present one and about one-fourth (23%) reported seven or more pregnancies. Approximately 60% of the women who were interviewed reported no fetal or postnatal deaths. However, it is recognized that these data are undocumented, retrospective information. One-eighth of the study group reported deaths of three or more children.

2. Education and Literacy

The study group of 104 pregnant women had little or no formal education and were largely illiterate (Table 5.29); a subset of 63 women showed the same characteristics. Literacy and formal education were considerably more unfavorable for the female than the male population. For example, 84.6% of the pregnant women and 39.8% of their husbands had received no formal education. Similarly, illiteracy was 87.4% among the females and 41.7% among the males. Among the small group of women who had received formal education (15.4%), only 10.6% exceeded six years; whereas among the men, 47.6% exceeded six years of formal education and 12.6% had received 12 years or more.

Approximately one-half of the males in this study (52.9%) were classified as literate as contrasted to only 10.7% of the women who reported both reading and writing skills.

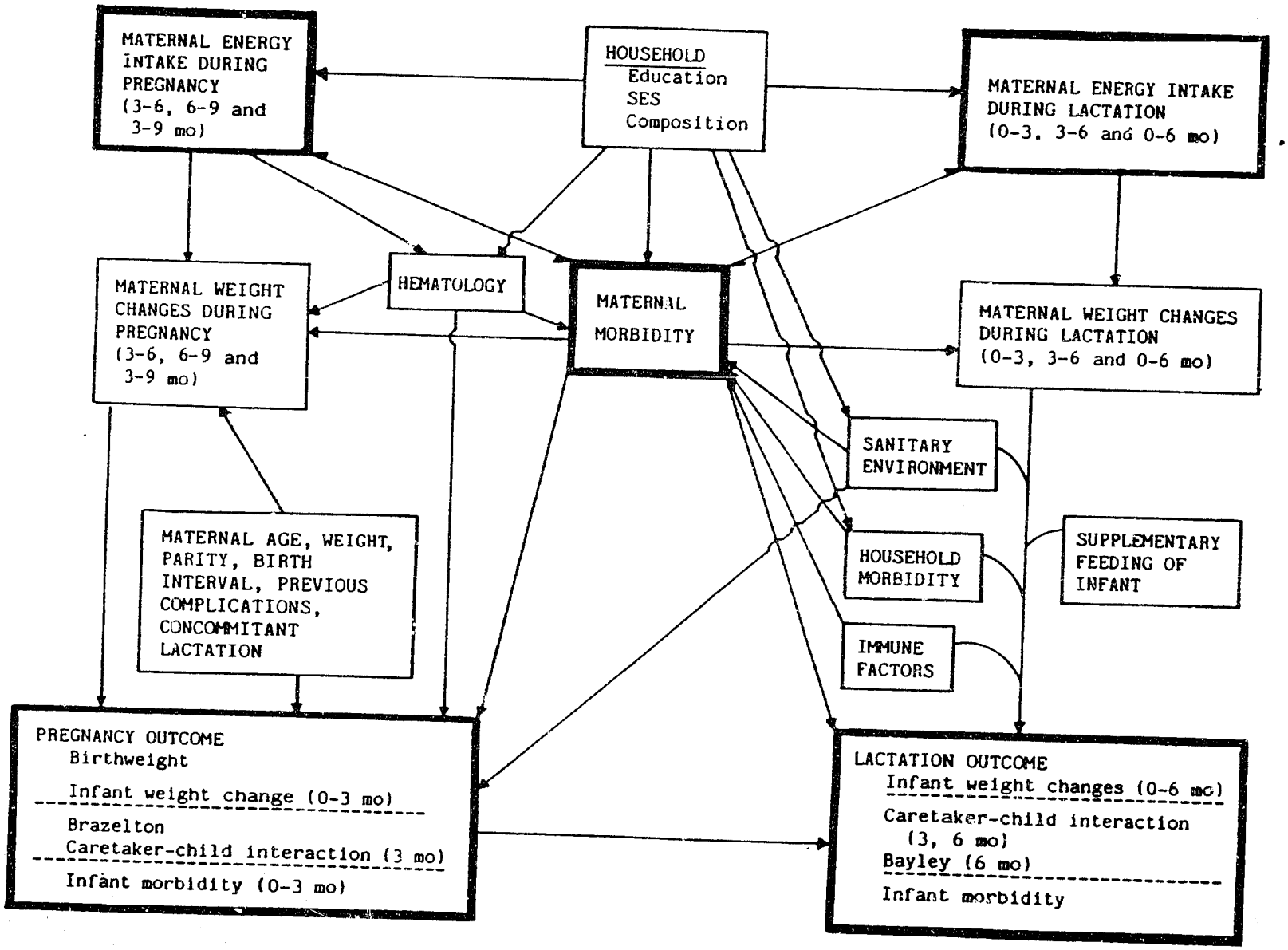

Fig 5.16 Proposed model for pregnancy and lactation outcome

Table 5.28.
Mean, range, and frequency distribution of age and reproductive history variables of pregnant women

	Mean ± SD (Range)	Years				
		<20	20-25	25-30	30-35	>35
		% of women*				
Age	25.9 ± 5.9 (17.1 -45.0)	14.4 (15)†	33.7 (35)	24.0 (25)	19.2 (20)	8.7 (9)
		Months				
		<18	18-24	24-30	30-36	36
		% of women‡				
Last birth interval	29.5 ± 9.9 (11.5 -61.9)	6.0 (5)	21.6 (18)	38.4 (32)	14.4 (12)	19.2 (16)
		Number				
		0	1-3	4-6	7-9	>10
		% of women*				
Parity	4.0 ± 2.8 (0 -13)	8.7 (9)	42.3 (44)	26.0 (27)	19.2 (20)	3.8 (4)
Live births	3.4 ± 2.4 (0 -11)	10.6 (11)	51.0 (53)	25.0 (26)	11.5 (12)	1.9 (2)
Living children	2.6 ± 1.6 (0 - 7)	9.6 (10)	67.3 (70)	20.2 (21)	2.9 (3)	0 (0)
		Number				
		0	1	2	3	>4
		% of women*				
Fetal deaths	0.6 ± 0.9 (0 - 4)	59.6 (62)	26.9 (28)	8.7 (9)	3.8 (4)	1.0 (1)
Postnatal deaths	0.8 ± 1.4 (0 - 7)	61.5 (64)	17.3 (18)	8.7 (9)	6.7 (7)	5.8 (6)

* n=104

† Number of subjects

‡ n=83

Table 5.29.
Formal education and literacy status of pregnant women and their husbands

	Pregnant women		Husbands	
	n	%	n	%
Formal education				
Professional degree	0	0	0	0
Post secondary	0	0	1	1.0
Secondary	0	0	12	11.7
Preparatory	1	1.0	11	10.7
Primary	15	14.4	38	36.9
None	88	84.6	41	39.8
Total	104		103	
Years of education				
≥12	0	0	13	12.6
6-9	11	10.6	36	35.0
1-5	5	4.8	13	12.6
None	88	84.6	41	39.8
Total	104		103	
Literacy status				
Literate	11	10.7	54	52.9
Reading ability only	2	1.9	6	5.9
Illiterate	90	87.4	42	41.2
Total	103		102	

B. Description of Households

Households were classified into four categories of socioeconomic status (SES) according to criteria described previously in the methodology chapter. More than two-thirds of the households among the study population of pregnant women were classified as low or low intermediate SES, and less than one-third as high or upper intermediate SES (Table 5.30). A relationship between these categories of SES and household sanitation indices were evident from the data shown in Table 5.30. Household sanitation indices were significantly higher ($p<0.05$) for the high and upper intermediate SES groups indicating better sanitation than for the two lower categories of SES. Household SES and sanitation variables will be discussed relative to several other variables in subsequent sections of this report.

Table 5.30.
Relationship of household socioeconomic status to household sanitation index

Household socioeconomic status	Households		Household sanitation index*
	Number	Percent	
High	16	14.9	$3.72 \pm 0.39^{\dagger,\ddagger}$
Upper intermediate	17	15.9	$3.66 \pm 0.34^{\ddagger}$
Lower intermediate	43	40.2	$3.36 \pm 0.37^{\S}$
Low	31	29.0	$3.27 \pm 0.37^{\S}$

* Higher indices indicate better sanitation † Mean ± SD ‡,§ Means with different superscripts differ significantly ($p<.05$)

C. Food Intake During Pregnancy and Lactation

1. Energy Intake

Estimates of energy intakes during the 2nd and 3rd trimesters of pregnancy and the first 6 months of lactation are shown in Table 5.31. All estimates of food intake for an individual were averaged over 3 and 6 month periods during pregnancy and lactation and the mean of these means for each time period are shown. The mean energy intake (kcal/day) of 80 women in the longitudinal study group for whom repeated food intake data were available was approximately 2000 kcal/day during the 2nd and 3rd trimester of pregnancy and approximately 2100 kcal/day during 0-3 and 3-6 months of lactation. The distribution of energy intake (Table 5.32) showed that during the 2nd and 3rd trimesters of pregnancy, 15.8 and 9.7% of the women, respectively, had mean intakes of less than 1500 kcal/day and two individuals had intakes less than 1000 kcal/day. Five lactating women had mean intakes between 1000-1500 kcal/day but none had intakes less than 1000 kcal/day.

When energy intake was expressed on a body weight basis, mean intake during pregnancy was approximately 30 kcal/kg/day and during lactation, 35 kcal/kg (Table 5.31). Mean energy intake of pregnant women in this study was somewhat less than 36 kcal/kg, the level which in the past has been recommended for optimal protein utilization during gestation (1). An updated series (2) indicated that, within reasonable limits, increased energy intake compensates for lesser protein intake during pregnancy and that the converse is also true. Also, as food intake increases, both energy and protein increase, and their influences cannot be separated in interpreting field data. Approximately one-half of the pregnant women (42.1 and 55.9% during the 2nd and 3rd trimesters, respectively) and one-third of the lactating women (26.8 and 33.8% during 0-3 and 3-6 months of lactation, respectively) had energy intakes less than 30 kcal/kg bodyweight (Table 5.32). Four pregnant women and one lactating woman consumed mean energy intakes of 20 kcal/kg/day or less.

About 85-90% of the women studied during 6 months of pregnancy or lactation consumed 12% or more of their daily energy intake as protein, and about 10-15% consumed 16% or more of their energy as protein (Table 5.32). The total protein content of the food supply in the US is reported to be 11-12% of the dietary energy (3). Similarly the FAO/WHO/UNU Committee (4) reported that most habitual diets derive 10-15% of their energy from protein.

Table 5.31.
Energy and protein intakes of pregnant and lactating women (longitudinal data)

	Kcal per day	Kcal per Kg body wt*	Total protein % of Kcal	Total protein g/d	Animal protein g/d	Plant protein g/d
Pregnancy, trimester						
2	2001 ± 475†	32.5 ± 9.1	13.4 ± 2.0	67.1 ± 18.7	27.2 ± 16.2**,††	39.9 ± 8.9
	(2030)‡	(31.5)	(13.0)	(63.5)	(26.0)	(40.0)
	950 - 3230§	16 - 59	9 - 19	30 - 115	0 - 66	21 - 55
3	1972 ± 445	30.4 ± 8.5	13.1 ± 2.2	65.6 ± 20.4	26.1 ± 15.5††	39.6 ± 10.8
	(1977)	(29.0)	(13.0)	(66.0)	(24.0)	(39.0)
	917 - 2884	14 - 56	7 - 19	23 - 133	0 - 77	19 - 76
2 & 3	1992 ± 409	31.4 ± 8.1	13.4 ± 1.5	67.0 ± 17.0	27.2 ± 12.9	39.8 ± 8.5
	(1999)	(30.0)	(13.0)	(66.0)	(24.5)	(38.5)
	962 - 3046	17 - 56	10 - 17	35 - 116	2 - 65	22 - 58
Lactation, mo						
0-3	2120 ± 401	35.1 ± 9.0	13.9 ± 3.0	73.7 ± 20.8	32.1 ± 20.5**	41.6 ± 10.2
	(2081)	(33.0)	(14.0)	(68.5)	(30.0)	(41.5)
	1223 - 3164	16 - 60	9 - 31	35 - 133	0 - 110	11 - 70
3-6	2097 ± 340	34.4 ± 7.6	13.6 ± 1.8	71.8 ± 16.1	29.0 ± 14.1**,††	42.8 ± 8.3
	(2089)	(35.0)	(13.5)	(72.0)	(28.5)	(42.0)
	1395 - 2934	21 - 54	10 - 19	38 - 11	54 - 68	23 - 66
0-6	2128 ± 280	35.3 ± 7.5	13.7 ± 1.6	73.5 ± 13.6	30.8 ± 12.9	42.7 ± 7.1
	(2073)	(34.5)	(14.0)	(72.5)	(29.0)	(42.0)
	1572 - 2949	21 - 60	10 - 20	48 - 123	6 - 70	30 - 68

* n=66-79; all other columns n=80

† Mean + SD

‡ Median

§ Range

**,†† Means in columns with different superscripts differ significantly ($p<.05$)

Table 5.32.
Frequency distribution of energy intake and percent of energy intake as protein during pregnancy and lactation (longitudinal data)

	Kcal/d					
	<1000	1000-1499	1500-1999	2000-2499	2500-2999	>3000
Pregnancy, trimester			% of women*			
2	1.2	14.6	32.9	37.8	9.8	3.7
	(1)†	(12)	(27)	(31)	(8)	(3)
3	2.4	7.3	41.5	36.6	12.2	0
	(2)	(6)	(34)	(30)	(10)	(0)
2 & 3	1.2	7.3	41.5	37.8	11.0	1.2
	(1)	(6)	(34)	(31)	(9)	(1)
Lactation, mo						
0-3	0	6.1	31.7	46.3	13.4	2.4
	(0)	(5)	(26)	(38)	(11)	(2)
3-6	0	3.7	32.5	51.8	11.0	0
	(0)	(3)	(27)	(43)	(9)	(0)
0-6	0	0	31.7	56.1	11.0	0
	(0)	(0)	(26)	(46)	(9)	(0)

	Kcal/Kg body weight				
	<20	20-29.9	30-39.9	40-49.9	>50
Pregnancy, trimester			% of women‡		
2	5.3	36.8	36.8	14.5	6.6
	(4)	(28)	(28)	(11)	(5)
3	10.3	45.6	30.9	11.8	1.5
	(7)	(31)	(21)	(8)	(1)
2 & 3	5.1	42.3	34.6	16.7	1.3
	(4)	(33)	(27)	(13)	(1)
Lactation, mo					
0-3	1.4	25.4	42.3	21.1	9.9
	(1)	(18)	(30)	(15)	(7)
3-6	0	33.8	36.9	26.2	3.1
	(0)	(22)	(24)	(17)	(21)
0-6	0	21.8	50.0	24.4	3.8
	(0)	(17)	(39)	(19)	(3)

Table 5.32. continued

	Total protein, % of Kcal				
	<12	12-13.9	14-15.9	16-17.9	>18
Pregnancy, trimester			% of women*		
2	14.6	41.5	30.5	8.5	4.9
	(12)	(34)	(25)	(7)	(4)
3	22.0	37.8	23.2	14.6	2.4
	(18)	(31)	(19)	(12)	(2)
2 & 3	7.3	48.8	35.4	8.5	0
	(6)	(40)	(29)	(7)	(0)
Lactation, mo					
0-3	14.6	34.1	34.1	13.4	3.7
	(12)	(28)	(28)	(11)	(3)
3-6	14.6	35.4	34.1	14.6	1.2
	(12)	(29)	(28)	(12)	(1)
0-6	4.9	42.7	41.5	9.8	1.2
	(4)	(35)	(34)	(8)	(1)

* n=82; † Number of subjects; ‡ n=68-82

2. Protein Intake

Mean total protein intake of the population of 80 pregnant women in this study was 67.1, 65.6 and 67.0 g/day during trimesters 2 and 3 and the trimesters combined, respectively (Table 5.31). During lactation mean intakes were slightly higher, 73.7, 71.8 and 73.5 g/day from 0-3, 3-6 and 0-6 months, respectively (Table 5.31). The recent FAO/WHO/UNU recommendations of 45 g/day for young women of 60 kg body weight, and an additional 6 g/day for pregnancy and 16 g/day for lactation were based on protein of the quality and digestibility of milk or eggs (4). Protein digestibility of the Egyptian diets was estimated to be 93% based on the assumption that rice, maize and beans contributed equally to the plant protein content of the diets and that the animal protein content of the diets was 100% digestible. Plant protein content of the Egyptian diets was estimated to be 88% digestible relative to the digestibility of milk or eggs (4). On the bases of these corrections for protein quality of Egyptian diets, recommended total protein intakes were 55 g/day for pregnancy and 66 g/day for lactation. More than one-half (57.9-58.5%) of the pregnant women in this study consumed 60 g or more of protein daily, and approximately one fourth (23.2-26.8%) consumed 80 g/day or higher (Table 5.33). The lowest estimated mean protein intakes were between 20 and 40 g/day. Only four women over the 6 months period of pregnancy observed, and none during the lactation period, had estimated mean protein intakes in the lowest range.

At each stage of pregnancy and lactation studied, mean animal protein intake comprised approximately 30 g of the total daily protein intake and plant protein about 40 g of the total (Table 5.31). More than one-third (39.0 to 42.7%) of the women during pregnancy and approximately one-half (48.2-52.4%) during lactation consumed 30 g/day or more of animal protein. About 15% and 10% of the women during pregnancy and lactation, respectively, consumed less than 10 g/day of animal protein (Table 5.33). Most women during pregnancy (86.4-89.1%) and lactation (90.3-100%) consumed 30 g/day or more of plant protein and about 15-20% of these women had mean intakes which exceeded 50 g/day (Table 5.33).

3. Relationship of Energy and Protein Intake to Socioeconomic Status

Energy intakes (kcal/day and kcal/kg body weight) during pregnancy were not significantly different among the four classifications of household socioeconomic status (SES) (Table 5.34). However, during the 6-month period of lactation observed, energy intakes, kcal/kg, were significantly less ($p<0.05$) in the two lower SES categories compared to the higher SES groups. Total protein intakes (g/day and % of kcal) during the periods of pregnancy and lactation observed were not significantly different among the different categories of household SES (Table 5.35). However, during the 6 month period of pregnancy observed, plant protein intake (g/day) was highest ($p<0.05$) in the lowest category of household SES, compared to the highest SES group.

Table 5.33.
Frequency distribution of total, animal, and plant protein intakes during pregnancy and lactation (longitudinal data)

	Total protein, g/d				
	20-39	40-59	60-79	80-99	>[illegible]
Pregnancy, trimester			% of women[a]		
2	4.9	36.6	31.7	20.7	6.1
	(4)[†]	(30)	(26)	(17)	(5)
3	9.8	24.4	42.7	18.3	4.9
	(8)	(20)	(35)	(15)	(4)
2 & 3	4.9	29.3	43.9	19.5	2.4
	(4)	(24)	(36)	(16)	(2)
Lactation, mo					
0-3	1.2	25.6	35.4	29.3	8.5
	(1)	(21)	(29)	(24)	(7)
3-6	1.2	22.0	43.9	29.3	3.7
	(1)	(18)	(36)	(24)	(3)
0-6	0	13.4	56.1	26.8	3.7
	(0)	(11)	(46)	(22)	(3)

	Animal protein, g/d			
	<10	10-29	30-49	>50
Pregnancy, trimester			% of women*	
2	14.6	42.7	31.7	11.0
	(12)	(35)	(26)	(9)
3	13.4	47.6	30.5	8.5
	(11)	(39)	(25)	(7)
2 & 3	6.1	54.9	34.1	4.9
	(5)	(45)	(28)	(4)
Lactation, mo				
0-3	8.5	39.0	39.0	13.4
	(7)	(32)	(32)	(11)
3-6	8.5	46.3	36.6	8.5
	(7)	(38)	(30)	(7)
0-6	3.7	47.6	40.2	8.5
	(3)	(39)	(33)	(7)

Table 5.33. continued

	Plant protein, g/d				
	10-19	20-29	30-39	40-49	>50
Pregnancy, trimester		% of women*			
2	0	13.4	35.4	34.1	17.1
	(0)	(11)	(29)	(28)	(14)
3	1.2	13.4	37.8	29.3	18.3
	(1)	(11)	(31)	(24)	(15)
2 & 3	0	11.0	43.9	29.3	15.9
	(0)	(9)	(36)	(24)	(13)
Lactation, mo					
0-3	1.2	8.5	26.8	46.3	17.1
	(1)	(7)	(22)	(38)	(14)
3-6	0	1.2	35.4	45.1	18.3
	(0)	(1)	(29)	(37)	(15)
0-6	0	0	32.9	52.4	14.6
	(0)	(0)	(27)	(43)	(12)

* n=82; † Number of subjects

Table 5.34.
Energy intake and percent of energy intake as protein for pregnant and lactating women classified by household socioeconomic status (longitudinal data)

	Household socioeconomic status			
	Upper		Lower	
	High n=15	Intermediate n=12	Intermediate n=31	Low n=24
Pregnancy, trimester		Kcal/d		
2	2024 ± 568* (2043)†	1930 ± 402 (2081)	2056 ± 464 (2067)	1953 ± 479 (1845)
3	1827 ± 459 (1895)	1885 ± 286 (1881)	1974 ± 443 (2097)	2103 ± 488 (2169)
2 & 3	1903 ± 473 (1912)	1874 ± 243 (1843)	2043 ± 423 (2086)	2040 ± 416 (1997)
Lactation, mo				
0-3	2096 ± 327 (2137)	2084 ± 470 (1981)	2124 ± 441 (2059)	2145 ± 377 (2081)
3-6	2158 ± 357 (2094)	2213 ± 209 (2153)	2051 ± 312 (2035)	2061 ± 411 (2027)
0-6	2164 ± 212 (2183)	2157 ± 242 (2172)	2113 ± 282 (2053)	2113 ± 341 (2053)

Table 5.34. continued

	Household socioeconomic status			
	Upper		Lower	
	High n=15	Intermediate n=12	Intermediate n=31	Low n=24
Pregnancy, trimester		**Kcal/Kg body weight‡**		
2	34.4 ± 13.5 (30.5)	33.6 ± 7.6 (35.0)	32.3 ± 8.4 (32.0)	31.2 ± 7.7 (30.0)
3	28.7 ± 10.6 (27.5)	30.4 ± 5.4 (28.5)	30.6 ± 9.5 (29.0)	31.3 ± 7.6 (28.0)
2 & 3	32.1 ± 11.8 (32.0)	31.2 ± 5.2 (29.0)	31.1 ± 8.4 (30.0)	31.4 ± 6.5 (30.0)
Lactation, mo				
0-3	36.1 ± 8.6 (35.0)	37.4 ± 9.9 (35.0)	33.3 ± 10.5 (32.0)	35.2 ± 7.1 (34.0)
3-6	33.7 ± 7.7 (33.0)	39.7 ± 3.7 (40.0)	33.4 ± 8.5 (32.5)	32.6 ± 7.1 (31.0)
0-6	37.2 ± 9.3§ (37.0)	38.5 ± 5.0§ (37.0)	33.6 ± 7.9** (32.0)	34.7 ± 6.5** (32.5)
Pregnancy, trimester		Total protein, % of Kcal		
2	14.0 ± 1.8 (14.0)	13.3 ± 2.3 (13.0)	13.4 ± 2.1 (13.0)	13.1 ± 1.8 (13.0)
3	13.6 ± 2.0 (14.0)	12.9 ± 1.8 (12.5)	13.5 ± 2.4 (13.0)	12.5 ± 2.3 (13.0)
2 & 3	14.0 ± 1.2 (14.0)	13.3 ± 1.2 (13.0)	13.6 ± 1.6 (14.0)	12.9 ± 1.5 (13.0)
Lactation, mo				
0-3	13.9 ± 1.7 (14.0)	14.0 ± 2.0 (13.5)	14.1 ± 2.9 (13.0)	13.7 ± 4.2 (13.0)
3-6	14.2 ± 1.7 (14.0)	13.7 ± 2.5 (13.0)	13.5 ± 1.8 (13.0)	13.3 ± 1.6 (13.5)
0-6	14.1 ± 1.5 (14.0)	14.1 ± 1.7 (14.0)	13.7 ± 1.5 (14.0)	13.5 ± 1.9 (13.0)

* Mean + SD; † Median; ‡ n ranges from 12-15, 11-12, 23-28 and 15-24 for high, upper intermediate, lower intermediate and low SES groups, respectively; §,** Means in rows with different superscripts differ significantly ($p<.05$).

Table 5.35.
Total, animal and plant protein intakes of pregnant and lactating women classified by household socioeconomic status (longitudinal data)

	Household socioeconomic status			
	Upper		Lower	
	High n=15	Intermediate n=12	Intermediate n=31	Low n=24
		Total protein, g/d		
Pregnancy, trimester				
2	70.6 ± 19.5* (70.0)†	64.4 ± 20.2 (60.0)	69.0 ± 17.0 (66.0)	63.9 ± 19.8 (56.5)
3	62.2 ± 17.6 (65.0)	61.4 ± 16.4 (62.0)	68.6 ± 23.7 (66.0)	65.9 ± 19.5 (70.0)
2 & 3	65.7 ± 16.4 (67.0)	61.9 ± 12.5 (58.0)	70.4 ± 19.0 (71.0)	65.9 ± 16.6 (65.5)
Lactation, mo				
0-3	72.6 ± 15.0 (72.0)	73.8 ± 25.3 (64.0)	74.6 ± 22.7 (66.0)	73.2 ± 20.3 (71.0)
3-6	77.5 ± 16.4 (76.0)	75.8 ± 10.9 (75.5)	69.9 ± 16.8 (69.0)	68.6 ± 16.6 (64.0)
0-6	76.7 ± 12.3 (78.0)	75.4 ± 10.4 (73.5)	72.7 ± 14.3 (71.0)	71.7 ± 15.2 (70.0)
		Animal protein, g/d		
Pregnancy, trimester				
2	32.1 ± 15.0 (31.0)	28.0 ± 19.3 (23.0)	28.4 ± 16.0 (27.0)	22.3 ± 15.4 (18.0)
3	26.6 ± 12.3 (23.0)	24.8 ± 15.4 (22.0)	29.5 ± 18.3 (28.0)	21.9 ± 13.2 (23.5)
2 & 3	29.0 ± 12.0‡,§ (27.0)	25.8 ± 12.1‡,§ (22.0)	30.3 ± 13.9‡ (29.0)	22.9 ± 12.0§ (21.5)
Lactation, mo				
0-3	31.9 ± 14.8 (30.0)	35.1 ± 21.0 (33.0)	33.1 ± 21.3 (26.0)	29.5 ± 22.9 (30.0)
3-6	34.1 ± 13.4 (34.0)	32.0 ± 16.2 (28.0)	28.0 ± 14.0 (28.0)	25.7 ± 13.1 (24.0)
0-6	33.7 ± 12.5 (35.0)	33.7 ± 12.3 (31.0)	30.2 ± 12.3 (29.0)	28.3 ± 14.3 (29.0)

Table 5.35. continued

	Household socioeconomic status			
	Upper		Lower	
	High n=15	Intermediate n=12	Intermediate n=31	Low n=24
Pregnancy, trimester		**Plant protein, g/d**		
2	38.6 ± 9.2 (43.0)	36.4 ± 7.0 (36.5)	40.7 ± 9.8 (41.0)	41.5 ± 8.4 (40.5)
3	35.6 ± 10.5‡ (33.0)	36.8 ± 4.6‡,§ (37.0)	39.1 ± 9.9‡,§ (38.0)	44.0 ± 12.9§ (44.5)
2 & 3	36.6 ± 9.2‡ (37.0)	36.0 ± 4.4‡ (37.0)	40.1 ± 8.5‡,§ (42.0)	43.2 ± 8.5d (42.5)
Lactation, mo				
0-3	40.7 ± 8.5 (41.0)	38.9 ± 11.2 (35.5)	41.4 ± 10.3 (41.0)	43.6 ± 10.8 (45.0)
3-6	43.3 ± 8.6 (44.0)	43.9 ± 9.9 (41.0)	42.0 ± 8.2 (42.0)	43.0 ± 8.0 (42.5)
0-6	43.0 ± 5.6 (43.0)	41.8 ± 8.5 (39.5)	42.5 ± 7.5 (41.0)	43.3 ± 7.1 (43.5)

* Mean ± SD; † Median; ‡,§ Means in rows with different superscripts are significantly different ($p<.05$).

D. Anthropometry of Pregnant Women

Descriptive statistics of the study population for anthropometry of pregnancy, whether cross-sectional for 45 to 117 women (Table 5.36) or longitudinal for 63 women with repeated measures (Table 5.37), were remarkably similar. For the most part, the longitudinal data for 63 women are described here. The population tended to be short in stature (mean of 155.3 ± 5.0 cm) and was characterized as normal to over-weight (mean of 60.9 ± 10.2 kg) for their height in early pregnancy. The mean body mass index (25.2 ± 4.0) in early pregnancy exceeded the range of 18.7 - 23.8, which has been suggested as desirable for women (5). The range of percent ideal weight for height (6), 90 - 168%, and the median percent of ideal weight (111%) in early pregnancy provided further evidence that the study population was normal to overweight. Mean body weight gain during the last 6 months of pregnancy observed was 7.9 ± 3.7 kg which was lower than the average weight gain of 12.5 kg or more, reported for pregnant women in developed countries (4). Little change was evident in arm circumference measurements during the last 6 months of pregnancy, but small, nonsignificant increases were observed in both bicep and tricep skinfold thickness.

E. Anthropometry of Lactating Women

Anthropometric data are presented for cross-sectional groups of lactating women ranging in numbers from 30 to 107 (Table 5.38) and also for a subset of 23 to 25 women for whom repeated measurements were obtained during lactation (Table 5.39). Descriptive statistics for the two groups were remarkably similar. From 1 to 6 months of lactation, essentially no change was evident in any of the parameters of mean body weight assessed. However, the range of -7.8 to 6.5 kg weight change over the 6-month period indicated considerable individual variation. During this time period, mean arm circumference was essentially unchanged, but mean values for both bicep and tricep skinfold thickness increased significantly ($p<0.003$ and $p<0.001$, respectively) during the 6-month period. The wide ranges evident in these measurements were indicative of marked individual differences. With the exception of skinfold thickness, little change was observed in the anthropometry of lactating women. Increased thickness of skinfolds suggested small

gains in body fat during the 6-month period of lactation and this was supported by the mean increase in body weight of approximately 2 kg from early pregnancy to the end of 6 months of lactation.

Table 5.36.
Anthropometry of pregnant women (cross-sectional data)

	Stage of gestation, months		
	3*	6†	9‡
Height, cm	155.4 + 5.3§ (117)** 141.3 - 169.5††	---	---
Body weight, kg	61.6 ± 10.4 (96) 44.8 - 102.3	63.2 ± 9.8 (63) 44.0 - 105.1	67.9 ± 10.1 (88) 49.6 - 96.0
% Ideal weight for height‡‡	116 ± 18.0 (95) 90 - 175	120 ± 16.0 (61) 94 - 178	128 ± 18.0 (86) 98 - 193
Body mass index	25.6 ± 4.1 (95) 19.6 - 38.9	---	---
	Stage of gestation, months		
	3-6	6-9	3-9
Body weight change, kg	3.7 ± 2.9 (45) -2.0 - 11.2	3.7 ± 2.5 (46) -0.4 - 9.5	7.4 ± 3.9 (73) - .9 - 17.8
	Stage of gestation, months		
	3	6	9
Arm circumference, cm	25.8 ± 3.0 (80) 21 - 37	25.4 ± 2.7 (52) 19 - 34	25.9 ± 2.9 (59) 20 - 35
Biceps skinfold, mm	9.4 ± 4.8 (83) 3 - 25	9.1 ± 4.3 (55) 3 - 22	9.6 ± 5.8 (56) 3 - 34
Triceps skinfold, mm	18.3 ± 7.2 (83) 6 - 36	18.9 ± 8.2 (55) 5 - 49	18.6 ± 7.4 (56) 7 - 44

* Birth - 190 ± 30 days

† Birth - 95 ± 15 days

‡ Birth - 15 ± 15 days

§ Mean ± SD

** Number of subjects

†† Range

‡‡ Jelliffe, D.B. The Assessment of the Nutritional Status of the Community. World Health Organization, Geneva, 1966;240-1.

Table 5.37.
Anthropometry of pregnant women (longitudinal data)

	Stage of gestation	
	3 months*	9 months†
	(n=63)	
Height, cm	155.3 ± 5.0‡ (155.5)§ 143.7 - 167.4**	---
Body weight, kg	60.9 ± 10.2 (58.6) 44.8 - 92.4	68.8 ± 10.1 (69.0) 49.6 - 95.5
% Ideal weight for height††	114 ± 18.0 (111) 90 - 168	129 ± 17.0 (127) 99 - 174
Body mass index	25.2 ± 4.0 (24.4) 19.6 - 37.0	---
Body weight change‡‡, kg	--- (7.5) -0.9 - 17.8	7.9 ± 3.7
Arm circumference§§, cm	25.8 ± 3.6 (25.4) 21.0 - 37.0	25.9 ± 2.8 (25.5) 21.0 - 32.5
Biceps skinfold***, mm	9.8 ± 5.5 (9) 4 - 25	10.5 ± 6.7 (10) 4 - 34
Triceps skinfold***, mm	18.3 ± 7.7 (18) 7 - 36	19.4 ± 8.3 (20) 7 - 44

* Birth - 190 ± 30 days

† Birth - 15 ± 15 days

‡ Mean ± SD

§ Median

** Range

†† Jelliffe, D.B. The Assessment of the Nutrition Status of the Community. World Health Organization, Geneva, 1966;240-1.

‡‡ (Birth - 15 ± 15 days) - (Birth - 190 ± 30 days)

§§ n=33

*** n=31

Table 5.38.
Anthropometry of lactating women (cross-sectional data)

	Stage of lactation, months		
	1*	3†	6‡
Height, cm	155.7 ± 5.3§ (107)** 141.3 - 169.5††	---	---
Body weight, kg	63.7 ± 10.8 (61) 46.3 - 104.5	61.3 ± 10.1 (61) 41.5 - 90.5	63.5 ± 11.9 (73) 47.0 -105.1
% Ideal weight for height‡‡	118 ± 18.0 (60) 93 - 178	117 ± 17.0 (57) 92 - 182	118 ± 22.0 (70) 76 -185.3
Body mass index	25.9 ± 4.1 (60) 20.4 - 39.5	25.7 ± 3.8 (57) 20.7 - 40.4	26.1 ± 4.8 (70) 16.3 - 41.2

	Stage of lactation, months		
	1-3	3-6	1-6
Body weight gain, kg	0.27 ± 2.1 (30) -4.2 - 4.3	0.01 ± 3.0 (40) -8.8 - 6.8	0.18 ± 3.5 (38) -7.8 - 6.5

	Stage of lactation, months		
	1	3	6
Arm circumference, cm	25.9 ± 4.1 (65) 20 - 36	26.0 ± 2.7 (64) 20 - 33	26.5 ± 3.3 (78) 20 - 36
Biceps skinfold, mm	9.8 ± 5.2 (67) 3 - 26	11.0 ± 6.2 (64) 4 - 34	13.0 ± 7.4 (77) 2 - 42
Triceps skinfold, mm	19.9 ± 7.3 (67) 7 - 40	21.5 ± 8.1 (64) 9 - 47	24.8 ± 10.4 (77) 6 - 60

* Day 30 postpartum ± 15 days

† Day 90 postpartum ± 15 days

‡ Day 180 postpartum ± 30 days

§ Mean ± SD

** Number of subjects

†† Range

‡‡ Jelliffe, D.B. The Assessment of the Nutritional Status of the Community. World Health Organization, Geneva, 1966;240-1.

Table 5.39.
Anthropometry of lactating women (longitudinal data)

	Stage of lactation, months	
	1*	6†
Height, cm (n=24)	156.7 ± 4.9‡ (156.6)§ 149.8 - 167.4**	
Body weight, kg (n=25)	63.7 ± 10.1 (61.4) 50.4 - 85.9	63.7 ± 10.0 (61.0) 51.8 - 87.2
% Ideal weight for height†† (n=24)	116.6 ± 17.5 (110.0) 93.8 - 159.9	116.9 ± 18.3 (111.6) 99.3 - 164.2
Body mass index (n=24)	25.6 ± 3.9 (24.3) 20.4 - 35.1	25.7 ± 4.1 (24.5) 21.6 - 36.1
Body weight change, kg (n=25)		-0.02± 3.2 (0.3) -7.8 - 6.5
Arm circumference, cm (n=24)	26.4 ± 3.7 (24.9) 21.8 - 36.0	26.9 ± 3.4 (25.6) 22.4 - 36.0
Biceps skinfold, mm (n=23)	10.7 ± 5.8 (9) 3 - 26	13.8 ± 8.0 (11) 4 - 36
Triceps skinfold, mm (n=23)	19.9 ± 7.6 (17) 8 - 35	25.3 ± 11.0 (24) 12 - 57

* Day 30 postpartum ± 15 days

† Day 180 postpartum ± 30 days

‡ Mean ± SD

§ Median

** Range

†† Jelliffe, D.B. The Assessment of the Nutritional Status of the Community. World Health Organization, Geneva, 1966;240-1

F. Morbidity of Pregnant and Lactating Women

The episodes of illnesses which were diagnosed for 73 women during pregnancy and the duration and severity of the episodes are summarized in Table 5.40. The mean number of illness episodes observed over at least 90 days of pregnancy during trimesters 2 and 3 was 2.2 per person with a mean duration of 6.0 days. More than one-third (35.7%) of the 157 illness episodes which were diagnosed were respiratory, and, in particular, common colds and bronchitis accounted for more than one-fourth (28.6%) of all illnesses experienced. A total of 56 respiratory illness episodes were reported and the mean duration of an episode was 6 days; more than one-half (51.8%) of these were classified as severe. The next most common category of illnesses was digestive, which accounted for 22.3% of all the illnesses reported.

Acute vomiting and diarrheal disease were the most common illnesses in this category and most of these, 28 of 34 episodes, were diagnosed as severe with a mean duration of 4.2 days. Thirteen episodes of fever with no other symptoms accounted for 8.4% of all illnesses. Two episodes of severe pyelonephritis and nine, non-severe episodes of cystitis of approximately 8 days mean duration were reported; skin, eye, and ear conditions with a mean duration of more than one week accounted for 20% of all illnesses during pregnancy but 80% of these were classified as non-severe.

The number of illness episodes experienced by 73 women during pregnancy, and described above, exceeded the number diagnosed for the women during at least 90 days of the first 6 months of lactation, 106 episodes as contrasted to 157 in pregnancy (Table 5.41). Mean illness duration of 5.8 days per episode during lactation was similar to that in pregnancy, and the percentage of all episodes which were described as severe in lactation (45.3%) and in pregnancy (45.9%) were remarkably similar. Respiratory illness (common cold, tonsillopharyngitis, and bronchitis) accounted for almost 40% of all illnesses during lactation. Digestive problems were reported less frequently in lactation than in pregnancy (11.3% and 22.3% of all episodes, respectively). Approximately 80% of the digestive episodes (acute vomiting, gastritis, and diarrheal disease) in lactation and pregnancy were classified as severe. Fever with and without symptoms and with a duration of 2.7 days comprised almost 10% of the total illness recorded during lactation, and more than 45% of these episodes were diagnosed as severe.

Over an observation period of at least 180 days of pregnancy and lactation, the average percentage of days ill was 3.4 ± 4.5% of time; the median was 2.0% (Table 5.42). All illnesses were included in this estimation except skin ailments which were of relatively long duration and non-severe. The range of percentage of days ill was 0-26.5% of time which indicated considerable individual variation in the days ill. More than one-third of the time ill was attributed to respiratory illness, and one individual was ill with respiratory problems 10-15% of time observed. However, about 60% of the women did not experience respiratory problems and 88% did not experience diarrhea. Among those who experienced diarrheal illness, more than 10% were ill 5% or less of the time observed. The percentage of days ill by stage of gestation or lactation is shown in Table 5.43. The percentage of days ill with all illnesses except skin ailments was similar in trimester 2 and 3 (4.3 and 4.4% of time observed, respectively) and somewhat less during lactation (3.7 and 2.7% of time at 0-3 and 3-6 months of lactation, respectively). In both pregnancy and lactation, respiratory and diarrheal illnesses comprised the largest percentage of days ill and the days with respiratory illnesses exceeded those with diarrhea. Diarrheal illnesses were experienced more frequently during pregnancy than lactation.

Table 5.40.
Morbidity of pregnant women: Type, duration and severity of illnesses

	Episodes				
Diagnosis*	Number	Duration, days Mean (range)	% severe	% of category	% of total
Skin					
Cellulitis/abcess boil	5	9.2 (5-16)	100.0	50.0	3.2
Fungus (ringworm)	1	2.0	0	4.5	0.6
Burn	1	8.0	0	4.5	0.6
Other	3	7.0 (5-7)	0	30.0	1.9
Total	10	7.7 (1-21)	50.0	100.0	6.4

Table 5.40. continued

Diagnosis*	Episodes: Number	Duration, days Mean (range)	% severe	% of category	% of total
Eye					
Conjunctivitis	14	6.4 (3-15)	0	82.3	8.9
Stye/blepharitis	1	9.0	0	5.9	0.6
Periorbital cellulitis	1	5.0	0	5.9	0.6
Other	1	8.0	0	5.9	0.6
Total	17	6.6 (2-17)	0	100.0	10.8
Ear					
Otitis externa	2	4.0 (3-5)	0	66.7	1.3
Otitis media	1	15.0	100.0	33.3	0.6
Total	3	7.7 (3-15)	33.3	100.0	1.9
Mouth/teeth/gums					
Gingivostomatitis	4	10.3 (8-14)	0	80.0	2.5
Thrush	1	9.0	0	20.0	0.6
Total	5	10.0 (8-14)	0	100.0	3.2
Respiratory					
Common cold	25	6.1 (2-25)	3.2	44.6	15.9
Chronic purulent rhinitis	1	7.0	0	1.8	0.6
Tonsillopharyngitis	10	4.6 (2-8)	40.0	17.9	6.4
Bronchitis	20	6.3 (2-16)	100.0	35.7	12.7
Total	56	5.9 (1-17)	51.8	100.0	35.7
Digestive					
Acute vomiting gastritis	21	5.3 (1-27)	100.0	60.0	13.4
Diarrheal disease	13	3.1 (2-7)	53.9	37.1	8.3
Heartburn/ indigestion	1	8.0	0	2.9	0.6
Total	35	4.6 (1-27)	80.0	100.0	22.3
Genitourinary					
Pyelonephritis	2	7.5 (7-8)	100.0	18.2	1.3
Cystitis	9	9.2 (3-23)	0	81.8	5.7
Total	11	8.9 (3-23)	18.2	100.0	7.0
Extremities/musculo/skeletal					
Fracture/dislocation/ sprain	2	6.5 (4-9)	0	100.0	1.3
Nervous system					
Rheumatoid arthritis	1	2.0	0	100.0	0.6

Table 5.40. continued

Diagnosis*	Episodes: Number	Duration, days Mean (range)	% severe	% of category	% of total
Fever					
Fever - no other signs/symptoms	13	3.7 (2-7)	23.1	76.5	8.4
Fever - with other signs/symptoms	4	5.0 (3-8)	100.0	23.5	2.5
Total	17	4.0 (2-8)	41.2	100.0	10.8
Total	**157**	**6.0 (1-27)**	**45.9**		**100.0**
Mean per woman	2.2				

* Data for 73 women observed for ≥90 days

Table 5.41.
Morbidity of lactating women: Type, duration and severity of illnesses

Diagnosis*	Episodes: Number	Duration, days Mean (range)	% severe	% of category	% of total
Skin					
Cellulitis/abcess boil	6	5.5 (1-8)	100.0	46.2	5.7
Fungus (ringworm)	2	14.0 (7-21)	0	15.4	1.9
Scabies	2	7.5 (7-8)	50.0	15.4	1.9
Other	3	9.7 (4-15)	0	23.0	2.8
Total	13	8.1 (1-21)	53.8	100.0	12.3
Eye					
Conjunctivitis	9	5.0 (2-8)	0	64.3	8.5
Stye/blepharitis	5	8.0 (2-17)	0	35.7	4.7
Total	14	6.1 (2-17)	0	100.0	13.2
Ear					
Other	1	8.0	0	100.0	0.9
Respiratory					
Common cold	21	4.7 (1-17)	19.1	50.0	19.8
Tonsillopharyngitis	10	5.3 (2-14)	40.0	23.8	9.4
Bronchitis	10	8.5 (2-17)	100.0	23.8	9.4
Asthma/wheezing	1	8.0	100.0	2.4	0.9
Total	42	5.8 (1-17)	45.2	100.0	39.6

Table 5.41. continued

Diagnosis*	Episodes: Number	Duration, days Mean (range)	% severe	% of category	% of total
Digestive					
Acute vomiting gastritis	4	2.8 (1-6)	100.0	33.3	3.8
Diarrheal disease	6	4.3 (1-9)	100.0	50.0	5.7
Acute abdominal pain	1	3.0	0	8.3	0.9
Other	1	8.0	0	8.3	0.9
Total	12	4.0 (1-9)	83.3	100.0	11.3
Genitourinary					
Pyelonephritis	3	3.7 (2-6)	100.0	27.3	2.8
Cystitis	8	7.6 (4-11)	12.5	72.7	7.5
Total	11	6.5 (2-11)	36.4	100.0	10.4
Nervous system					
Osteoarthritis	1	6.0	0	50.0	0.9
Rheumatoid arthritis	1	11.0	0	50.0	0.9
Total	2	8.5 (6-11)	0	100.0	1.9
Fever					
Fever - no other signs/symptoms	3	2.0 (1-3)	66.7	33.3	2.8
Fever - with other signs/symptoms	6	3.0 (2-5)	100.0	66.7	5.7
Total	9	2.7 (1-5)	88.9	100.0	8.5
Miscellaneous					
Breast swelling and pain	2	6.5 (2-11)	0	100.0	1.9
Total	**106**	**5.8 (1-27)**	**45.3**		**100.0**
Mean per woman	1.5				

* Data for 73 women observed for ≥90 days.

Table 5.42.
Percentage of time pregnant/lactating women were ill with all illnesses (except skin ailments) and with diarrhea and respiratory illnesses

	Illness*		
	All except skin	Diarrhea	Respiratory
		% of time ill	
Mean	3.4	0.5	1.6
SD	4.5	0.5	2.2
Median	2.0	-	-
Range	0 - 26.5	0 - 2.9	0 - 13.1
% of time ill		% of women	
None	26.9	88.2	59.1
<5	50.5	11.8	31.2
5-9.9	16.1	-	-
10-14.9	3.2	-	1.1
≥15	3.2	-	-

* Data for 93 women over a period of 141 ± 30 days of pregnancy and 152 ± 23 days of lactation

Table 5.43.
Morbidity of pregnant/lactating women: Percentage of time ill by stage of gestation/lactation

Stage of gestation/lactation	n	Illness All	All except skin	Diarrhea	Respiratory
			% of time ill		
Trimester 2	99	4.3 ± 10.1*	3.4 ± 8.0	0.7 ± 0.8	1.7 ± 3.2
Trimester 3	98	4.4 ± 10.1	4.0 ± 9.9	0.8 ± 0.7	1.8 ± 4.8
Lactation, 0-3 mo	98	3.7 ± 8.0	2.6 ± 5.7	0.3 ± 1.4	1.5 ± 3.9
Lactation, 3-6 mo	97	2.7 ± 5.3	2.4 ± 4.5	0.2 ± 0.6	1.1 ± 3.3
Mean		4.0 ± 5.1	3.4 ± 4.5	0.5 ± 0.5	1.6 ± 2.2

* Mean ± SD of 141 ± 30 days during pregnancy and 152 ± 23 days of lactation

G. Pregnancy Outcome

Birth weights are shown for 102 infants (Table 5.44) and also for a subset of 73 infants (Table 5.45) for whom repeated weight measurements were made during the first 6 months. Descriptive data for these two groups were remarkably similar but only data for the subset are discussed here. Birth weights showed an almost normal distribution according to the National Center for Health Statistics (NCHS) standards (7,8) (Figure 5.17); mean weight of females was 3172 ± 395 g and of males, 3303 ± 346 g. The frequency distribution of weights (Table 5.46) indicated that 2.5% of the male infants and 3.0% of the females were of low birth weight (LBW) or less than the 5th percentile of weight (NCHS). The incidence of low birth weight infants in this study was unusually low and could be misleading since some mothers did

not allow their infants to be weighed at the time of birth and some mothers refused to participate in the study when their pregnancy outcome was unfavorable.

1. Relationship of Different Variables to Birth Weight

a. Maternal Anthropometry and Food Intake

Among all of the variables which were examined in this study for their relationship to birth weight, maternal anthropometry showed the greatest influence. Maternal anthropometry variables which significantly influenced birth weight were body weight (Figure 5.18) and various derivations of this measurement, i.e. body mass index in early pregnancy (Figure 5.19) and percent of ideal weight for height (6) (Figure 5.18). Also maternal triceps skinfold thickness and upper arm circumference (Figure 5.20) were significantly related to birth weight.

With the exception of height and body mass index, which were measured only in early pregnancy, anthropometric measurements made at either 3 or 9 months of pregnancy were significantly related to birth weight. At 3 and 9 months of gestation, maternal body weight explained 18 and 25%, respectively, of the variation in birth weight (Figure 5.18); triceps skinfold thickness, 23 and 25%, respectively (Figure 5.20); biceps skinfold thickness, 14 and 14%, respectively; and upper arm circumference, 16 and 14%, respectively (Figure 5.20). Thus the predictive power of the anthropometry variables for birth weight was comparable whether measurements were made in the early or late stages of pregnancy.

By simple regression analyses, neither maternal height nor weight gain from 3 to 9 months of pregnancy (Figure 5.19) was significantly related to birth weight. However, in a subset of 35 women, for whom weight information was available, weight gain during the 2nd trimester (3-6 months of gestation) was a significant predictor (R^2=0.22; $p<0.005$) of birth weight (Figure 5.19). Although height was not directly related to birth weight, it was significantly correlated with maternal weight (R^2=0.10; $p<0.008$). Hence height indirectly influenced birth weight since taller mothers were heavier and heavier mothers delivered heavier infants.

Table 5.44.
Weights of infants at birth, 1, 3 and 6 months of age (cross-sectional data)

	Age of infant, months			
	Birth	1	3	6
Male	n=61	n=56	n=47	n=47
Weight, g	3328 ± 440*	4323 ± 648	5842 ± 783	7103 ± 1009
	(3318)†	(4259)	(5957)	(7085)
	2278 - 4348‡	2142 - 5941	3748 - 7655	4736 -10115
Weight, % of 50th percentile (NCHS)§	102 ± 13	101 ± 15	98 ± 13	90 ± 13
	(101)	(99)	(100)	(90)
	69 - 133	50 - 138	63 - 128	60 - 129
Female	n=41	n=39	n=39	n=36
Weight, g	3207 ± 369	4052 ± 404	5361 ± 663	6560 ± 823
	(3228)	(4048)	(5293)	(6593)
	2228 - 3962	3178 - 4810	3920 - 6785	4548 - 8374
Weight, % of 50th percentile (NCHS)§	99 ± 11	102 ± 10	99 ± 12	91 ± 11
	(99)	(102)	(98)	(91)
	69 - 123	80 - 121	73 - 125	63 - 116

* Mean ± SD; † Median; ‡ Range; § National Center for Health Statistics

Neither maternal energy intake nor intakes of total, animal, or plant protein from 3 to 9 months of gestation were significantly correlated with birth weight as indicated by simple regression analyses (Figure 5.21). Nevertheless, some of the effect of food intake would appear to be through maternal body weight prior to pregnancy. Body weight of the mother in early pregnancy was clearly a significant predictor of birth weight.

b. Maternal Morbidity

Maternal morbidity variables (% of time sick with all illnesses and % of time sick with all illnesses excluding skin ailments) were not significantly related to birth weight. Possible indirect effects of maternal morbidity on birth weight were also examined, i.e. the relationship of morbidity to various maternal and household variables, which may in turn influence birth weight. The maternal variables which were examined included age, education, food intake, and anthropometry; the household variables were SES and sanitation-hygiene index. Again, simple regression analyses showed that maternal morbidity was not significantly related to any of these maternal or household variables.

Table 5.45.
Weights of infants at birth, 1, 3 and 6 months of age (longitudinal data)

	Age of infant, months			
	Birth	1	3	6
Male (n=40)				
Weight, g	3303 ± 346* (3310)† 2278 - 3926‡	4348 ± 578 (4351) 3066 - 5941	5860 ± 690 (5959) 4150 - 6984	7107 ± 897 (7051) 4736 - 9048
Weight, % of 50th percentile (NCHS)§	100.9 ± 10.6 (101.2) 70 - 120	101.3 ± 13.5 (101.4) 71 - 138	97.9 ± 11.5 (99.6) 69 - 117	90.5 ± 11.4 (89.6) 60 - 115
Female (n=33)				
Weight, g	3172 ± 395 (3131) 2228 - 3962	4064 ± 396 (4048) 3236 - 4810	5387 ± 682 (5293) 3920 - 6785	6587 ± 819 (6590) 4548 - 8374
Weight, % of 50th percentile (NCHS)	98.2 ± 12.2 (96.9) 69 - 123	102.0 ± 9.95 (101.7) 81 - 121	99.7 ± 12.6 (98.0) 72.5 - 126	91.3 ± 11.4 (91.4) 63 - 116

* Mean ± SD; † Median; ‡ Range; § National Center Health Statistics

c. Maternal Hematological Status

The incidence of anemia (hemoglobin concentration <11g/dl) in the population of pregnant women studied in Kalama increased gradually from 15% in the 1st trimester to 26% in the 2nd and 3rd trimesters. Since mean cell hemoglobin concentration did not change significantly from the 1st to the 2nd and 3rd trimesters, the increase in anemia was related largely to hemodilution, which is known to increase progressively from early to late pregnancy. After 6 months of lactation, 34.6% of the women studied were anemic (hemoglobin concentration g/dl), an incidence higher than that observed in early pregnancy, suggesting that anemia was aggravated by the present pregnancy. Mean plasma ferritin

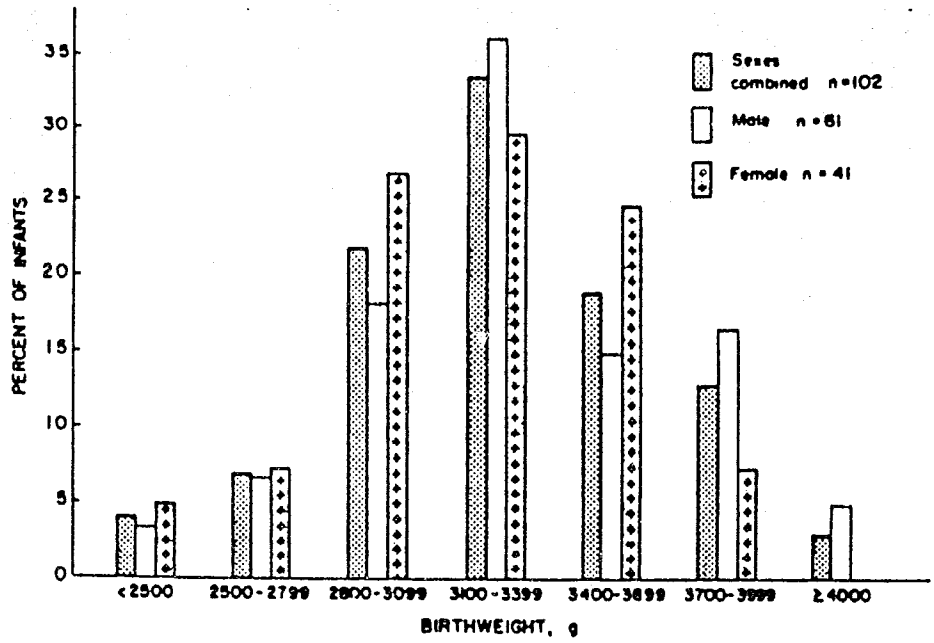

FIG 5.17. Frequency distribution of infants by birthweight

concentration of primigravida (48.7 ± 12.2) was significantly ($p<.02$) higher than that of women with 4 to 6 previous pregnancies (23.8 ± 13.0), suggesting that several successive pregnancies resulted in a drain on iron stores. This was further supported by the finding that mean hematocrit concentration (36% ± 3) of younger women (<20 yrs) was significantly ($p<0.05$) higher than that (33% ± 3) of older women (30-34 yrs). Hematology parameters in the 1st and 2nd trimesters were not significantly related to maternal weight gain in pregnancy or birth weight. However, in the 3rd trimester, hemoglobin concentration tended ($p<0.12$) to be associated positively with birth weight.

d. Other Maternal and Household Variables

The significant positive correlation of maternal age and parity with birth weight was possibly an indirect effect of body weight since both of these variables were significantly correlated with maternal weight at 3 months of pregnancy (Figure 5.22). In this study, none of the literacy of the mother or father, type of occupation of father (Table 5.47), socioeconomic status of the household (Table 5.48), or household sanitation index (Table 5.49) were significantly related to birth weight, but, as will be discussed later, some of these variables were significantly related to infant weight at 6 months of age.

2. Summary of Household and Maternal Variables Associated With Low Birth Weight

Several household and maternal variables were examined for their possible association with low birth weight (LBW) and normal birth weight (NBW) in this study (Table 5.50). Among all of the maternal variables examined, age and anthropometry were the variables which showed the greatest mean differences between mothers of LBW and NBW infants. Mothers of LBW infants were younger in age (21.4 yr) than mothers of NBW (26.0 yr) and throughout pregnancy their body weight was significantly less than mothers of NBW infants. In early and mid-pregnancy, mean body weight of mothers of LBW infants was approximately 10 kg less, and in late pregnancy, 13 kg less than for mothers of NBW infants. Mean weight gain over 3 to 9 months of pregnancy was only 4.8 kg for mothers of LBW compared to 8.1 kg for mothers of NBW. Mean energy and protein intakes during the 6-month period of pregnancy observed were generally similar for mothers of LBW and NBW infants. Also, household SES, sanitation index, and maternal education and literacy variables were similar for LBW and NBW. In this study, maternal weight prior to the pregnancy and weight gains in pregnancy were clearly the most important variables associated with low birth weight. Simple regression analyses of birth weight with all of the maternal variables which were discussed previously in the pregnancy outcome section are summarized in Table 5.51.

Table 5.46.
Frequency distribution of infants by percentiles of weight at different ages (longitudinal data)

Sex and age	Percentiles of weight (NCHS)*							
	<5	5-10	10-25	25-50	50-75	75-90	90-95	>95
	% of infants							
Male								
Birth	2.5	-	20.0	20.0	37.5	15.0	5.0	-
(40)†	(1)	-	(8)	(8)	(15)	(6)	(2)	-
1 month	2.5	2.5	10.0	32.5	27.5	17.5	5.0	2.5
	(1)	(1)	(4)	(13)	(11)	(7)	(2)	(1)
3 months	5.0	5.0	10.0	32.5	35.0	12.5	-	-
	(2)	(2)	(4)	(13)	(14)	(5)	-	-
6 months	15.0	17.5	25.0	22.5	15.0	5.0	-	-
	(6)	(7)	(10)	(9)	(6)	(2)	-	-
	% of infants							
Female								
Birth	3.0	3.0	21.2	27.3	21.2	9.1	12.1	3.0
(33)	(1)	(1)	(7)	(9)	(7)	(3)	(4)	(1)
1 month	-	-	15.2	30.3	30.3	15.2	9.1	-
	-	-	(5)	(10)	(10)	(5)	(3)	-
3 months	3.0	3.0	15.2	36.4	21.2	9.1	9.1	3.0
	(1)	(1)	(5)	(12)	(7)	(3)	(3)	(3)
6 months	12.1	18.2	24.2	37.3	12.1	6.0	-	-
	(4)	(6)	(8)	(9)	(4)	(2)	-	-

* National Center for Health Statistics

† Number of infants

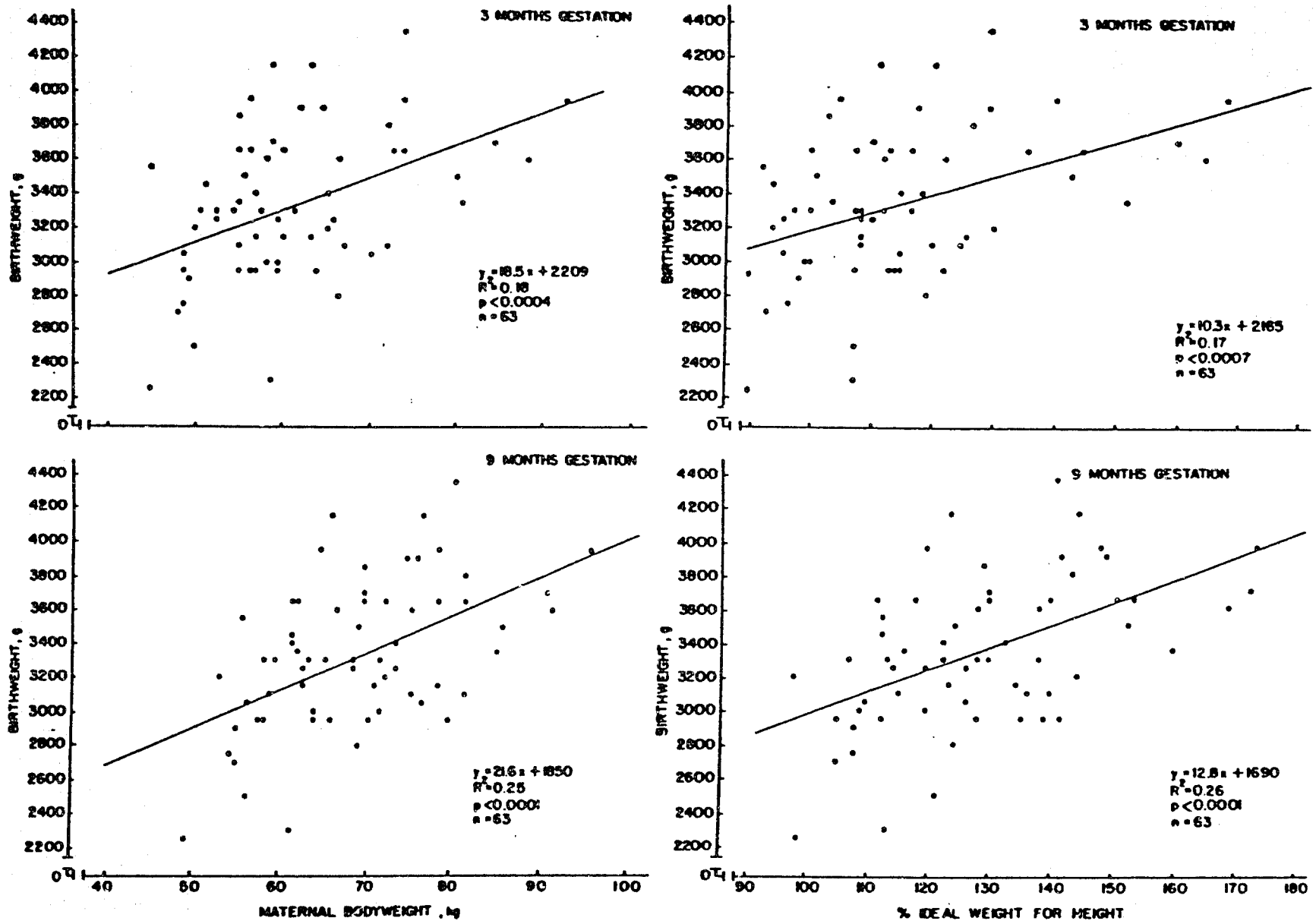

FIG 5.18. Relationship of maternal bodyweight and % of ideal weight for height at 3 and 9 months gestation to birth weight

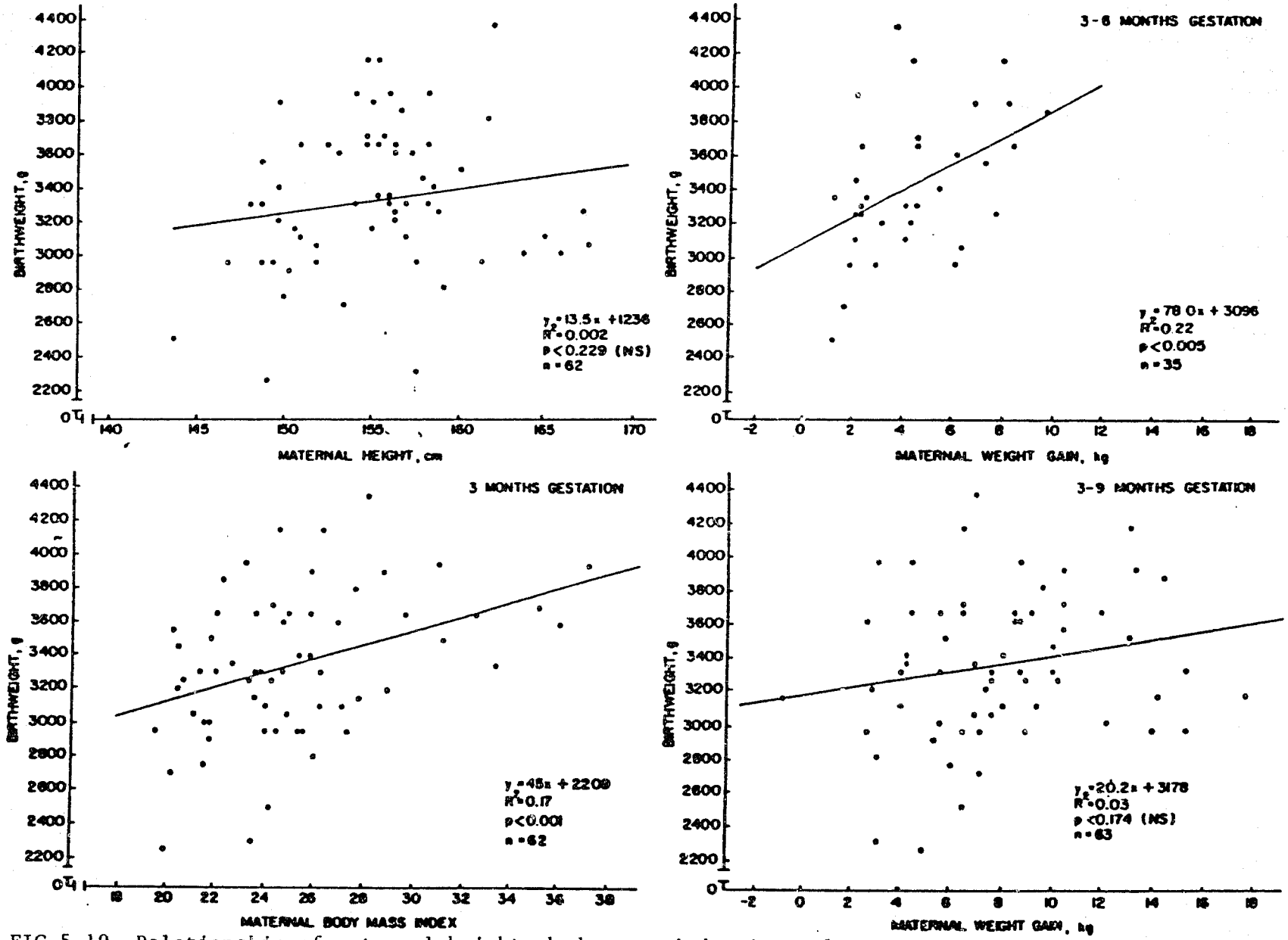

FIG 5.19. Relationship of maternal height, body mass index in early pregnancy and weight gain from 3 to 6 and 3 to 9 months gestation to birthweight

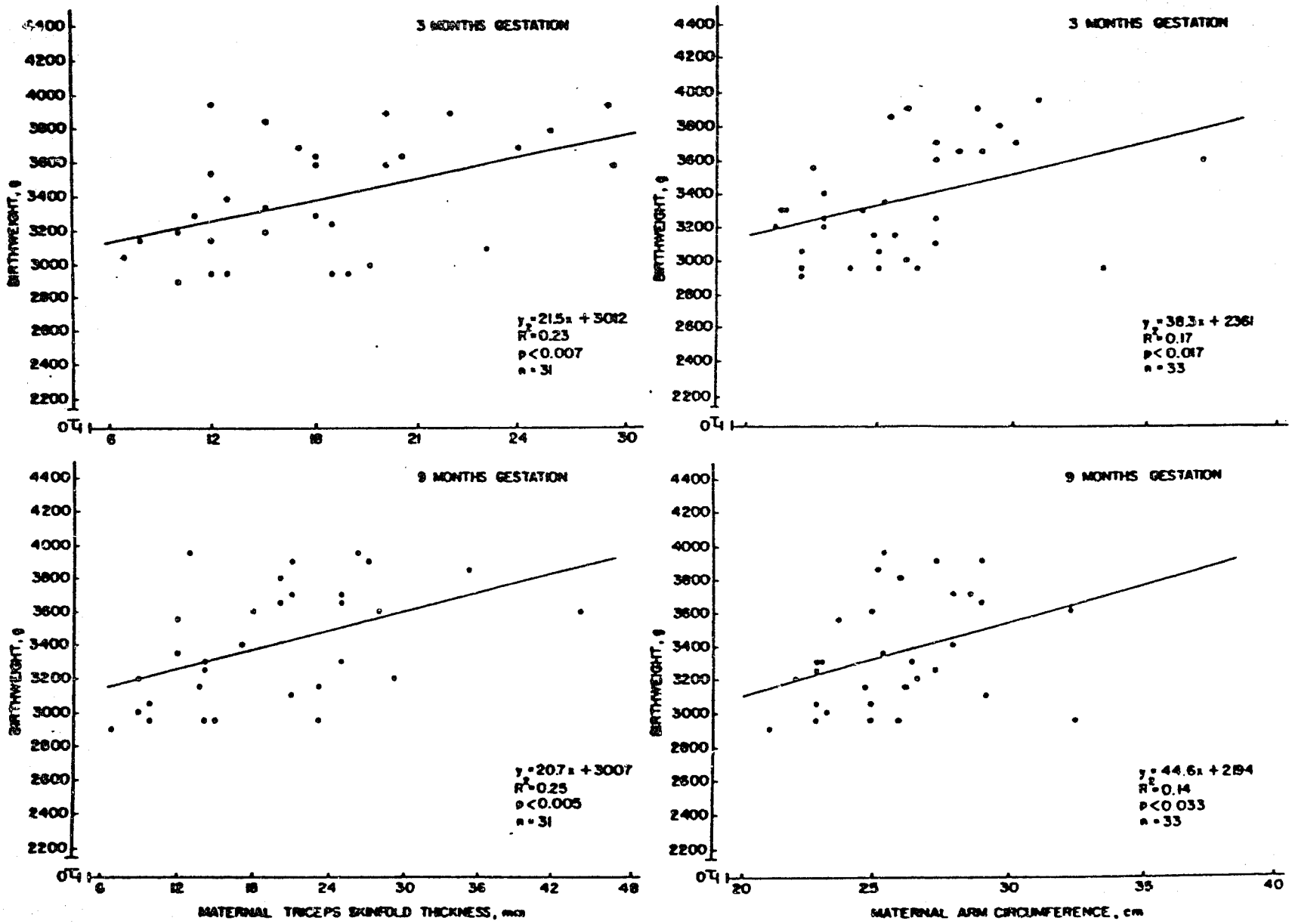

FIG 5.20. Relationship of maternal triceps skinfold thickness and arm circumference at 3 and 9 months gestation to birthweight

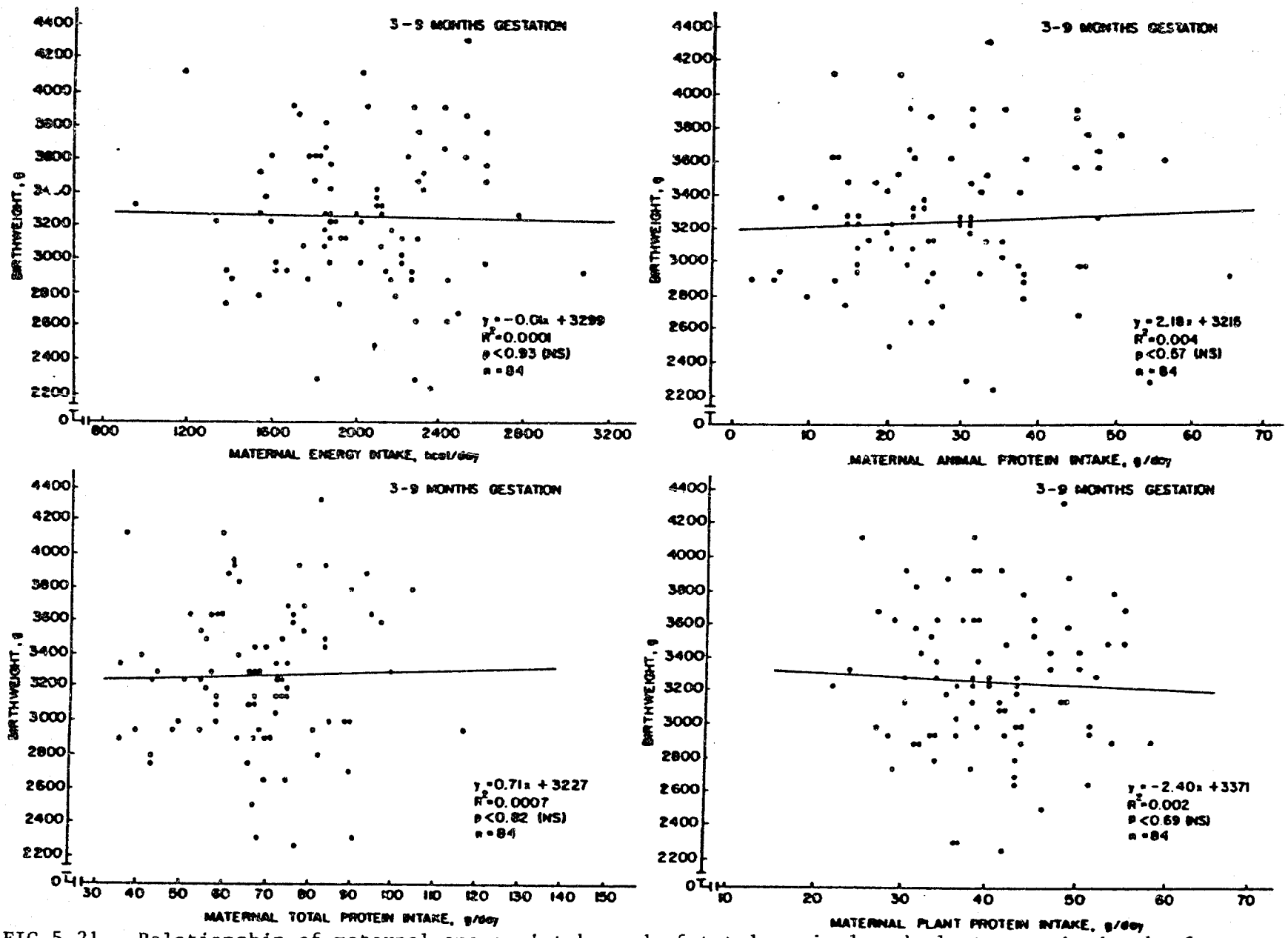

FIG 5.21. Relationship of maternal energy intake and of total, animal, and plant protein intake from 3 to 9 months gestation to birthweight

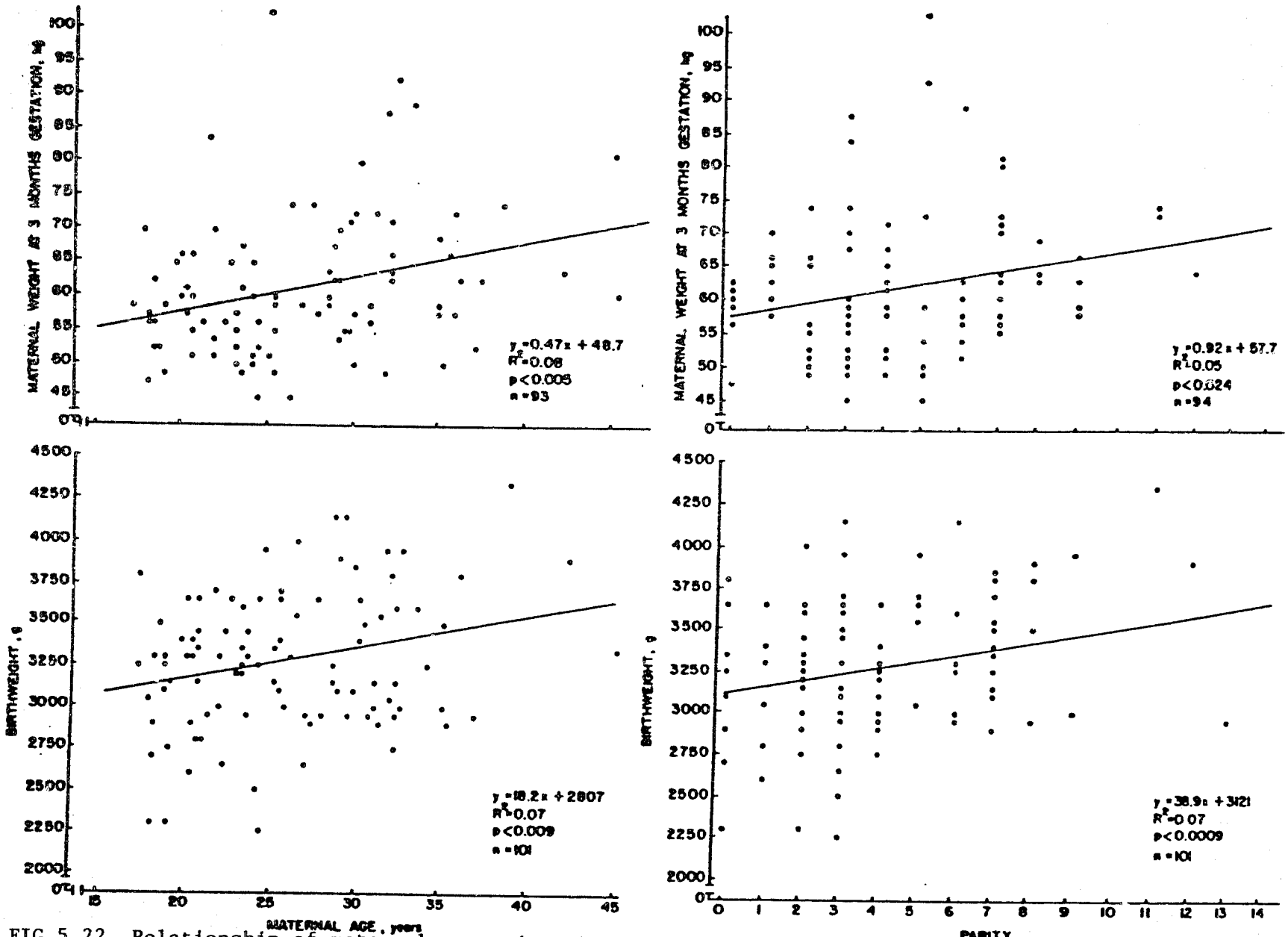

FIG 5.22. Relationship of maternal age and parity to maternal weight at 3 months gestation and to birthweight

Table 5.47.
Relationship of paternal and maternal literacy, education, and type of occupation to infant weight, expressed as percent of the 50th percentile at birth and 6 months of age

	Infant weight, % of the 50th percentile (NCHS)*			
	Birth		6 months of age	
	Paternal	Maternal	Paternal	Maternal
Literacy	n=39	n=87	n=32	n=66
Illiterate	100.5 ± 13.5†	100.1 ± 13.0	85.9 ± 12.0	89.9 ± 11.9
	(99.7)‡	(100.3)	(87.5)	(90.2)
	69.6 - 132.9§	68.9 - 132.9	60.3 - 105.4	60.3 - 116.1
	n=60	n=13	n=49	n=15
Literate	101.2 ± 11.7	104.3 ± 10.2	93.7 ± 11.5	94.1 ± 13.7
	(100.7)	(106.0)	(91.4)	(91.7)
	70.7 - 127.5	88.7 - 120.3	70.8 - 128.8	70.8 - 128.8
Education, years	n=38	n=85	n=30	n=63
0	100.5 ± 13.7	100.4 ± 13.1	86.5 ± 11.6	90.1 ± 12.1
	(98.9)	(100.6)	(87.5)	(90.3)
	69.6 - 132.9	68.9 - 132.9	60.3 - 105.4	60.3 - 116.1
	n=13	n=5	n=8	n=7
1-5	103.8 ± 12.9	105.1 ± 10.9	92.3 ± 19.7	92.0 ± 18.4
	(104.7)	(111.8)	(89.4)	(86.8)
	79.3 - 127.5	91.3 - 113.6	60.3 - 105.4	70.8 - 128.8
	n=36	n=11	n=32	n=13
6-9	101.0 ± 10.9	100.7 ± 10.4	92.7 ± 9.8	92.6 ± 9.1
	(100.7)	(100.0)	(91.4)	(92.4)
	81.4 - 127.3	88.7 - 120.3	70.8 - 113.5	78.0 - 113.5
	n=13		n=12	
12-17	99.0 ± 12.4	-	94.9 ± 12.0	-
	(101.6)		(94.7)	
	70.7 - 116.1		80.5 - 116.1	
Type of occupation	n=25		n=19	
Agricultural	98.3 ± 10.8	-	89.6 ± 13.7	-
	(96.9)		(91.4)	
	76.7 - 119.8		63.0 - 107.7	
	n=37		n=32	
Nonagricultural, public sector	100.3 ± 14.4	-	89.8 ± 11.9	-
	(99.0)		(89.6)	
	69.6 - 132.9		60.3 - 128.8	
	n=35		n=28	
Nonagricultural, private	103.8 ± 11.1	-	91.8 ± 12.3	-
	(103.0)		(90.6)	
	79.3 - 127.5		70.8 - 116.1	

* National Center for Health Statistics

† Mean ± SD

‡ Median

§ Range

Table 5.48.
Comparison of socioeconomic status (SES) and infant weight expressed as percent of the median at birth and 6 months of age

Household SES group	Infant weight, % of the 50th percentile (NCHS)*	
	Birth	6 months
High	n=13 97.2 ± 10.3† (100.7)‡ 84.0 - 111.9§	n=14 92.6 + 7.9** (91.9) 80.5 - 109.5
Upper intermediate	n=16 102.9 ± 13.8 (100.4) 70.7 - 127.3	n=12 95.7 ± 14.9** (101.9) 70.8 - 115.2
Lower intermediate	n=43 101.2 ± 12.6 (100.7) 69.6 - 127.5	n=36 91.8 ± 9.1**,†† (91.0) 77.3 - 116.1
Low	n=29 100.0 ± 13.5 (100.0) 68.9 - 132.9	n=21 84.5 ± 15.5†† (82.3) 60.3 - 128.8

* National Center for Health Statistics ; † Mean ± SD; ‡ Median; § Range
**,†† Means in columns with different letters are significantly different ($p<0.05$)

Table 5.49.
Comparison of household sanitation index and infant weight expressed as percent of the median (NCHS) at birth and 6 months of age

Household sanitation index†	Infant weight, % of the 50th percentile (NCHS)*	
	Birth	6 months
2.5 - 2.99	n=16 98.1 ± 9.6‡ (95.3)§ 84.1 - 120.0**	n=13 84.6 + 14.6 (86.8) 60.3 - 105.0
3.0 - 3.24	n=16 103.0 ± 15.5 (107.3) 68.9 - 127.3	n=11 93.3 ± 8.6 (96.4) 77.3 - 105.2
3.25- 3.49	n=24 101.6 ± 11.6 (100.3) 81.4 - 122.6	n=17 92.8 ± 10.1 (91.4) 72.6 - 109.5
3.50- 3.74	n=22 101.9 ± 11.6 (99.9) 81.5 - 132.9	n=16 91.2 ± 11.0 (90.8) 78.2 - 116.1
3.75- 3.99	n=9 93.0 ± 12.1 (92.9) 70.7 - 108.7	n=7 88.9 ± 12.6 (83.0) 78.1 - 115.2
4.0 - 4.5	n=9 98.3 ± 16.0 (96.9) 76.7 - 121.5	n=6 91.6 ± 9.4 (90.2) 80.5 - 105.4

* National Center for Health Statistics

† Higher indices indicate better sanitation

‡ Mean ± SD

§ Median

** Range

Table 5.50.
Household and maternal variables associated with normal and low birth weight

	Normal birth weight		Low birth weight				
			Infant	A	B	C	D
	n	Mean ± SD	Mean				
Infant							
Birth weight, g	98	3318 ± 375	2325*	2228	2278	2314	2478
% 50th percentile (NCHS)							
Birth	98	101.9 ±11.4	71.5*	68.9	69.6	70.7	76.7
3 months	73	99.3 ±11.7	87.6†	85.9	79.6	‡	97.4
6 months	71	91.0 ±11.5	82.9	83.7	77.3	‡	87.8
Household							
Socioeconomic status§	97	2.9 ± 1.0	3	4	3	2	3
Sanitation index**	93	3.4 ± 0.4	3.6	3.2	3.0	3.9	4.2
Mother							
Age, yrs	97	26.0 ± 5.9	21.4	24.4	18.1	19.2	24.0
Formal education, yrs	97	0.9 ± 2.2	0	0	0	0	0
Literacy††	96	1.1 ± 0.3	1	1	1	1	1
Previous fetal deaths,n	97	0.6 ± 0.9	0.75	0	2	0	1
Anthropometry							
Height,cm(prepregnant)	90	155.9 ± 4.7	153.4	149.7	155.2	157.6	143.7
Body weight, kg							
Trimester 1	70	61.8 ± 9.7	51.1†	44.8	-	58.5	50.0
Trimester 2	42	63.1 ± 8.0	53.4†	-	55.8	-	51.0
Trimester 3	69	69.1 ± 9.6	55.9*	49.6	-	61.5	56.5
Body weight gain, kg (3-9 mo gestation)	60	8.1 ± 3.7	4.8	4.8	-	3.0	6.5
% ideal weight for height							
Trimester 1	69	115.8 ±17.7	101.8	89.9	-	107.7	107.7
Trimester 2	41	119.4 ±13.8	107.5	-	105.0	-	109.9
Trimester 3	68	129.0 ±17.1	111.5†	99.5	-	113.2	121.7
Food intake, 3-9 mo gestation							
Kcal/d	81	2009 ± 395	2125	2352	1800	2275	2072
Kcal/kg body weight	77	31.9 ± 7.4	39.3*	48	32	38	39
Protein, total, g/d	81	67.7 ±17.0	74.8	76	67	90	66
Protein, animal, g/d	81	27.7 ±13.1	34.8	34	31	54	20
Protein, plant, g/d	81	40.1 ± 8.0	40.0	42	36	36	46

* $p<0.05$; † $p<0.10$, significantly different from normal birth weight infants; ‡ Infant died in perinatal period

§ 1=high and 4=low SES groups; ** Scores increase with better sanitation

†† 1=illiterate, 2=literate

Table 5.51.
Simple regressions of maternal variables and birth weight expressed as percent of the 50th percentile (NCHS)*

Independent variable	n	Regression coefficient	SE	p	R^2
Mother					
Age, years	101	0.55	0.21	0.01	0.07
Intercept		86.4	5.5		
Parity	101	1.18	0.44	0.009	0.07
Intercept		95.9	2.15		
Weight, 3 mo gestation, kg	63	0.58	0.15	0.0003	0.19
Intercept		67.4	9.3		
Arm circumference, 3 mo gestation, cm	35	1.24	0.45	0.009	0.19
Intercept		70.5	11.7		
Biceps skinfold thickness, 3 mo gestation, mm	31	0.75	0.33	0.03	0.15
Intercept		97.4	3.7		
Triceps skinfold thickness, 3 mo gestation, mm	31	0.69	0.22	0.004	0.25
Intercept		92.1	4.4		

* National Center for Health Statistics

H. Multiple Regression Models For Predicting Birth Weight

Relationships between birth weight and various other measures have been discussed previously. In this section, the combined effects of collections of variables on this outcome were investigated using multiple regression techniques. To properly interpret the results, a few preliminary remarks about the methods which were used are needed. More detailed information is presented in the statistics section of this report. The same comments also apply to the section on models for predicting infant weight at 6 months of age.

When predictor variables are correlated, it is often the case that several different subsets of variables give essentially the same predictive power. A procedure such as stepwise regression that gives just one of these statistically indistinguishable subsets as the answer may be misleading. The method used here is based on examination of all possible subsets of predictors as implemented in SAS PROC RSQUARE. The CP criterion was used to select subset models.

The following variables were considered as candidate predictors for birth weight expressed as percent of 50th percentile (NCHS):

Characteristics of the Mother

- Age
- Education, years
- Parity
- Number of fetal deaths
- Average kilocalorie, animal protein and plant protein intake across the second and third trimesters of pregnancy
- Height
- Weight at 3 months of pregnancy
- Weight gain, 3 to 9 months of pregnancy
- Percentage of time sick excluding skin ailments
- Percentage of time sick with skin ailments

Characteristics of the Household

- SES
- Sanitation-hygiene index
- Infant/child mortality

In selecting the candidate predictors, several considerations were taken into account. First, given the purpose of the CRSP, several food intake variables were included as candidate predictors. Second, there was a trade-off between the inclusion of more variables and the consequent loss of cases due to missing values. If there were too few cases relative to the number of variables, then there was a danger of overfitting.

One interpretation of a regression coefficient is that it represents the change in the predicted variable that would be associated with a one unit change in the predictor, given that the values of all other predictors are held constant at their average. For predictors which are not correlated with the set of other predictors, this is a very reasonable view. However, in cases when the predictors are correlated, this interpretation can be misleading. Because of the correlation of two variables with parity, number of fetal deaths and infant/child mortality, these variables were excluded as candidate predictors. After these exclusions, the other candidate predictors given above represented a reasonable compromise. In this analysis, 49 cases were used.

When 13 variables were included, the R^2 (squared multiple correlation) was 0.50. At this level some overfitting was likely and this statistic should be viewed with caution. The CP criterion pointed to only one candidate model as the best predictor. The model included early pregnancy weight and weight gain with an R^2 of 0.37. The next step was to examine the selected two-variable model in a multiple regression analysis. This resulted in a sample size of 63. Early pregnancy weight and weight gain explained 27% of the variation in birth weight (Table 5.52). When the model included body mass index or percent of the ideal weight for height instead of weight per se, R^2 changed only slightly (0.29 and 0.30 respectively). The effects of body weight in early pregnancy or derivations of this measurement, and weight gain during 3 to 9 months of pregnancy on birth weight were clearly significant. The largest (least significant) p-value for these variables was 0.01 and the coefficients were positive and reasonably consistent across models.

Although maternal age and parity showed a significant relationship to birth weight in simple regressions, these variables were not significant in multiple regression analysis. As mentioned before, the effect of age and parity on birth weight appeared to be due to their relationsip to early pregnancy weight. Among all of the variables examined, age had the strongest correlation with early pregnancy weight (R^2=0.17, p=0.0003). Older mothers were heavier than younger mothers and delivered infants of larger birth weight. Younger mothers appeared to face greater risks of delivering low birth weight infants than older mothers and should therefore be given appropriate nutritional support early in the pregnancy or preferably prior to the pregnancy to reduce the risk of low birth weight.

Table 5.52.
Multiple regression models for predicting birth weight, expressed as percent of the 50th percentile (NCHS)*

Independent variable	n	Regression coefficient	SE	p	R^2
Model 1					
Weight in early pregnancy, kg	63	0.65	0.15	0.0002	0.27
Weight gain during pregnancy, kg (2nd and 3rd trimester)		1.02	0.40	0.01	
Intercept		54.7	10.2		
Model 2					
Percent of ideal weight for height in early pregnancy	63	0.39	0.08	0.0003	0.30
Weight gain during pregnancy, kg (2nd and 3rd trimester)		1.32	0.43	0.003	
Intercept		43.1	11.12		
Model 3					
Body mass index in early pregnancy	63	1.72	0.39	0.0004	0.29
Weight gain during pregnancy, kg (2nd and 3rd trimester)		1.34	0.43	0.003	
Intercept		48.8	11.2		

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I. Multiple Regression Analyses Predicting Early Pregnancy Weight and Weight Gain During Pregnancy

Multiple regression analysis of variables affecting birth weight showed that only early pregnancy weight and weight gain during second and third trimesters were significant predictors of birth weight. To study the effect of food intake and other variables on early pregnancy weight and weight gain, again the PROC RSQUARE analysis was used. The independent variables used were: mother's years of education, age, parity, height, animal protein, plant protein, and kcal intake during the second and third trimesters (used as a proxy for the previous food intake) and household socioeconomic status and sanitation-hygiene index. Among 9 predictors and 60 cases, age was the best single predictor of early pregnancy weight, showing a R^2 of 0.21 compared to 0.35 when all variables were used. The CP criterion clearly showed that the combination of age and height is the best prediction model. Multiple regression analysis showed that these two variables explained 25% of the variation in early pregnancy weight (Table 5.53).

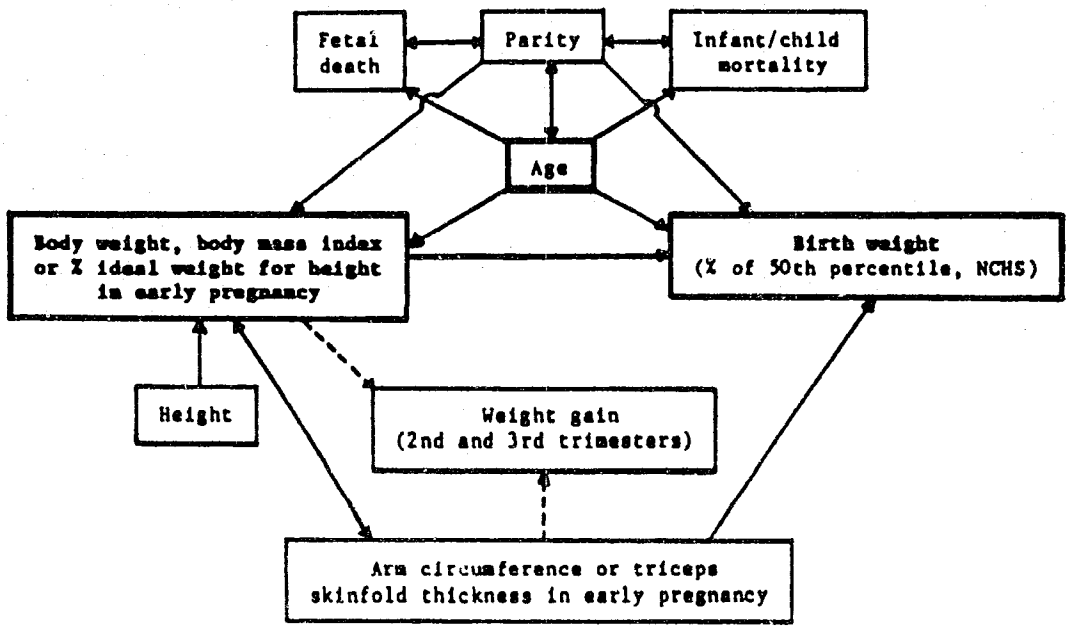
The independent variables considered as predictors of maternal weight gain included the same 9 variables used for predicting early pregnancy weight plus two morbidity variables (% time sick with skin ailments and % time sick excluding skin ailments) and early pregnancy weight. In this analysis, 49 cases were included and R^2 for all 12 variables was 0.35. Early pregnancy weight was the best single predictor (R^2=0.09). The CP criterion showed three candidate models for predicting weight gain, each including two variables with R^2 ranging from 0.17 to 0.19. The candidate models were parity and age, parity and early pregnancy weight, and SES and early pregnancy weight. The multiple regression analysis of these candidate models showed that among 63 mothers, age and parity were the best predictors of weight gain with R^2 of 0.17 (Table 5.53). The regression coefficient for age was negative and for parity was positive. If instead of age, early pregnancy weight was used, R^2 dropped to 0.13 and its regression coefficient was negative. This showed that if parity was held constant, older or heavier women gained less weight during pregnancy than younger or lighter women.

Energy and protein intakes of mothers during pregnancy were not directly associated with birth weight. Nevertheless some of the effect of food intake would obviously be through body weight prior to and during pregnancy, which clearly affected birth weight. All simple and multiple regression analyses of various independent variables with birth weight are summarized in Figure 5.23. Significant relationships between maternal age, parity, and weight with birth weight suggested the need for further analysis using the least squares means procedure to control for the age effect on early pregnancy weight, a significant predictor of birth weight.

Table 5.53.
Multiple regression analysis for predicting early pregnancy weight and weight gain during the second and third trimesters

Independent variable	Regression coefficient	SE	p	R^2
	Dependent variable: Early pregnancy weight, kg (n=72)			
Age, years	0.66	0.17	0.0003	0.25
Height, cm	0.59	0.21	0.004	
Intercept				
	Dependent variable: Weight gain, kg (n=63)			
Age, years	-0.32	0.11	0.004	0.17
Parity	0.88	0.25	0.05	
Intercept	12.6	2.2		

(A) SIMPLE REGRESSIONS



(B) MULTIPLE REGRESSION

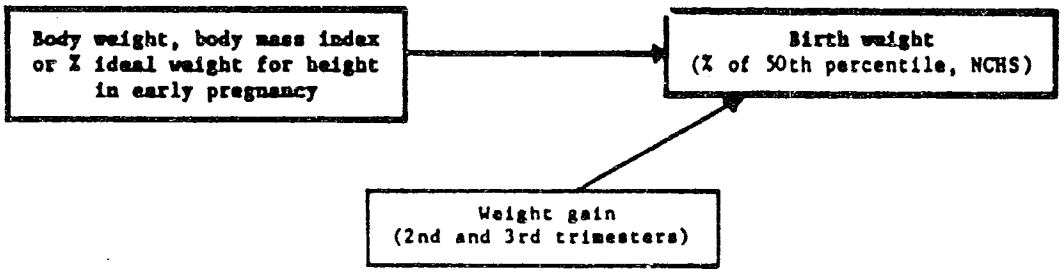


FIG 5.23. Summary of variables related to birth weight by simple regression (A) and multiple regression (B) analyses. ——— significant effect ($p<0.05$); - - - trend ($p<0.01$)

J. Growth of Infants

1. Weight, Length and Weight for Length

Weight and length data for male and female infants from birth to 3 months of age followed a pattern of normal distribution which closely resembled the NCHS standards (Tables 5.44 and 5.54). Hence both mean weight and length of male and female infants from birth to 3 months of age were approximately 100% of the 50th percentile of NCHS standards (Tables 5.44 and 5.54). Ranges were similar for the sexes - 69-123% for weight and 95-113% for length. By 3 months of age, some growth faltering in both weight and length of male and female infants was evident and continued to increase progressively to 6 months of age. At this age, weights of male and female infants were 90.5 and 91.3%, respectively, of the 50th percentile of weight (NCHS) and ranged from 60-116%; ranges were similar for both sexes. The percent of male and female infants whose weights were less than the 5th percentile of weight increased from 5.0% and 3.0%, respectively, at 3 months of age, to 15.0 and 12.1%, respectively, at 6 months of age (Table 5.46 and Figure 5.24). Data for length of infants were limited in contrast to that for weight and consequently interpretation of this measurement was restricted to a smaller data set than for weight. Nevertheless some stunting in length was evident for both male and female infants at 6 months of age, 95.1 and 97.5%, respectively, of the 50th percentile (NCHS) with a range of 88-102% for the sexes combined (Table 5.54).

Weight and length data of infants from birth to 6 months of age were reported as weight/age, length/age and weight/length with mean, median and range of Z-scores, NCHS percentiles and percent of 50th percentile (NCHS) for each parameter (Table 5.55). From birth to 3 months of age the three parameters of weight and length were approximately 100% of the 50th percentile (NCHS) and Z-scores were near zero. However, the range of Z-scores and percentiles indicated that some infants were faltering in weight/age, length/age and weight/length at each age studied. By 6 months of age, mean weight/age Z-score dropped to -0.75 with a range from -3.19 to 2.39, mean percentile was 29.2 (0.07-99.2), and percent of median percentile was 90.8 (60.3-129.7). The changes observed may be related in part to the use of NCHS standards, which are based largely on growth data of formula-fed infants. In this study, mean changes in length/age in Z-score and percentiles at 6 months were similar to those observed for weight/age, but the trend was somewhat more negative than that observed for weight. As a result of these changes, weight/length showed the least change in Z-score and percentile values over the 6 months. Nevertheless, the range of weight/length Z-scores from -4.22 to 1.35 and percentiles from 0 to 91.2 at 6 months indicated extreme differences in the growth of some individuals.

2. Head Circumference, Arm Circumference and Skinfolds

Data for head circumference, arm circumference, and bicep and tricep skinfold measurements at birth, 1, 3 and 6 months of age are shown for male (Table 5.56) and female (Table 5.57) infants. Mean head circumference for male and female infants was approximately 100% of the 50th percentile of NCHS standards from birth to 3 months of age and at 6 months had decreased slightly for both sexes to 96% of the median percentile. The range of variation in head circumference (cm and % of 50th percentile, NCHS) was about 20% between the low and high values at each age studied. Limited information about age related changes in arm circumference and in bicep and tricep skinfolds of infants has precluded comprehensive data on percentile distributions. Data for skinfold thickness of infants are relatively few except for newborns. This is attributed in part to the difficulty in obtaining these measurements of infants where patience and continuing practice are essential. Thus the data of Karlberg et al (9), from a study of Finnish children, of skinfold measurements over the first 3 years are particularly valuable. The mean tricep skinfolds of Egyptian infants in this study were approximately 100% of the 50th percentile standards of Karlberg at 1 and 3 months for both sexes and at 6 months fell slightly below this standard. At 6 months of age, mean bicep skinfold thickness of both male and female infants was essentially the same thickness as observed at 3 months of age. Also, the mean upper arm circumference at six months was strikingly low for both male and female infants, 12.0 and 12.3 cm, respectively, as compared to means of 15.4 and 15.0 reported by Huenemann et al (10) for more than 200 healthy male and female infants, respectively, in Berkeley. These observations in conjunction with the extreme variation in arm circumference and in skinfolds noted at each age studied suggested that some infants did not accumulate fat stores normally and that by 6 months of age these infants had less than normal fat deposits.

Table 5.54.
Lengths of infants at birth, 1, 3 and 6 months of age (cross-sectional)

	Age of infant, months			
	Birth	1	3	6
Male	n=34	n=16	n=22	n=26
Length, cm	50.5 ± 1.2*	54.1 ± 3.4	59.6 ± 2.1	64.5 ± 2.6
	(51.0)†	(54.1)	(59.3)	(64.8)
	48 - 52‡	46 - 59	55 - 64	60 - 69
Length, % of 50th percentile (NCHS)§	100.0 ± 2.4	99.0 ± 6.3	97.4 ± 3.5	95.1 ± 3.8
	(100.9)	(98.6)	(96.9)	(95.5)
	95 - 103	84 - 107	90 - 104	88 - 102
Female	n=21	n=13	n=17	n=13
Length, cm	50.3 ± 1.7	53.0 ± 2.4	59.3 ± 2.8	64.3 ± 2.1
	(50.0)	(52.6)	(58.1)	(64.8)
	48 - 56	0 - 57	55 - 64	60 - 66
Length, % of 50th percentile (NCHS)	100.7 ± 3.5	99.0 ± 4.5	99.6 ± 4.7	97.5 ± 3.1
	(100.2)	(98.2)	(97.5)	(98.3)
	96 - 113	93 - 107	93 - 108	91 - 100

* Mean ± SD

† Median

‡ Range

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FIG 5.24. Frequency distribution of infants by percentiles of weight (NCHS) at birth and at 3 months of age.

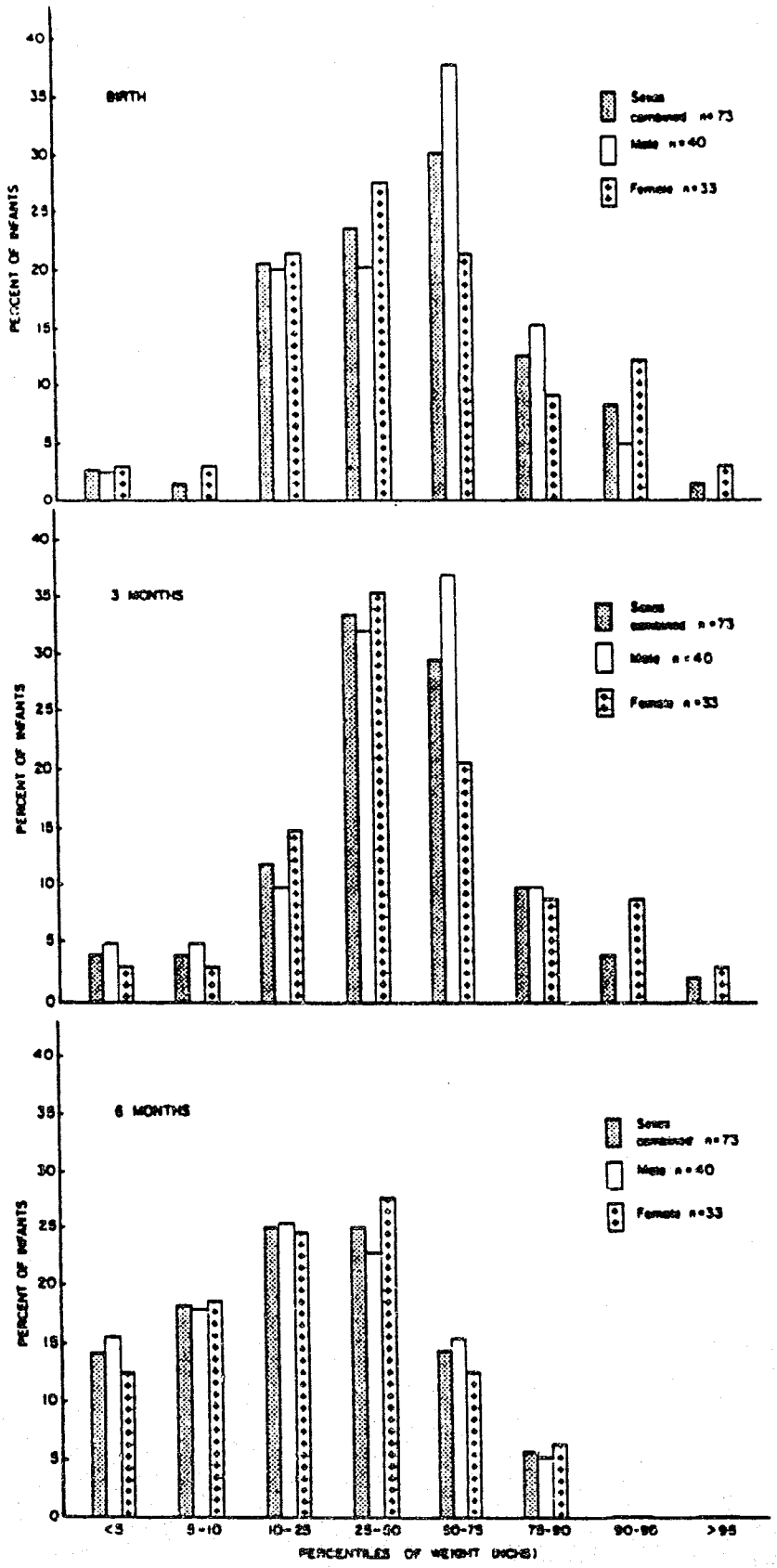

Table 5.55.
Infant weight and length data compared to NCHS standards (sexes combined)

	Age of infant, months			
	Birth	1	3	6
	n=95	n=100	n=87	n=82
Weight/age				
Z score	0.01 ± 0.92*	0.04 ± 0.90	-0.09 ± 0.87	-0.75 ± 1.01
	(0.05)†	(0.02)	(-0.06)	(-0.8)
	-2.42 - 2.16‡	-3.13 - 1.85	-2.36 - 1.97	-3.19 - 2.39
Percentile (NCHS)§	50.6 ± 27.7	51.9 ± 26.9	47.5 ± 26.2	29.2 ± 25.8
	(51.9)	(50.8)	(47.6)	(21.2)
	0.8 - 98.5	0.09 - 96.8	0.91 - 97.5	0.07 - 99.2
% of 50th percentile (NCHS)	100.3 ± 12.8	100.3 ± 13.8	98.4 ± 12.9	90.8 ± 12.5
	(100.7)	(100.3)	(99.0)	(90.2)
	69.0 -133.0	50.1 -128.7	62.5 -128.6	60.3 -129.7
	n=54	n=28	n=39	n=31
Length/age				
Z score	0.05 ± 0.65	-0.20 ± 1.29	-0.34 ± 0.99	-0.84 ± 1.24
	(0.06)	(-0.25)	(-0.56)	(-0.8)
	-1.09 - 2.74	-3.64 - 1.74	-2.23 - 2.07	-2.96 - 3.81
Percentile (NCHS)	51.1 ± 20.3	45.9 ± 34.1	39.2 ± 29.6	26.0 ± 24.5
	(52.5)	(40.2)	(28.7)	(21.3)
	13.9 - 99.7	0.01 - 95.9	1.28 - 98.1	0.16 - 99.8
% of 50th percentile (NCHS)	100.2 ± 2.87	99.1 ± 5.69	98.5 ± 4.21	96.7 ± 4.91
	(100.3)	(98.9)	(97.6)	(96.9)
	95.1 -111.8	83.6 -107.5	90.3 -108.7	88.3 -115.0
	n=49	n=27	n=39	n=31
Weight/length				
Z score	-0.30 ± 0.77	0.44 ± 0.9	40.41 ± 0.76	-0.17 ± 1.10
	(-0.42)	(0.39)	(0.42)	(-0.13)
	-2.24 - 1.25	-1.55 - 2.42	-1.13 - 2.28	-4.22 - 1.35
Percentile (NCHS)	40.9 ± 24.2	63.1 ± 27.2	62.7 ± 22.6	47.9 ± 27.9
	(33.6)	(65.1)	(66.4)	(44.88)
	1.25 - 89.5	6.1 - 99.2	12.9 - 98.9	0 - 91.2
% of 50th percentile (NCHS)	97.2 ± 9.8	106.3 ± 11.9	105.5 ± 9.5	98.9 ± 10.5
	(95.1)	(105.6)	(105.4)	(98.7)
	75.2 -119.5	82.1 -126.6	86.2 -130.6	66.5 -115.6

* Mean ± SD

† Median

‡ Range

§ National Center for Health StatisticsTable 5.56. Head circumference, arm circumference and skinfold thickness of male infants (cross-sectional data)

Table 5.56.
Head circumference, arm circumference and skinfold thickness of male infants (cross-sectional data)

	Age of infant, months			
	Birth	1	3	6
Head circumference, cm	n=18 35.2 ± 2.01* (35.2)† 30.0 - 38.0‡	n=20 37.3 ± 1.69 (37.5) 33.4 - 40.0	n=25 40.3 ± 1.46 (40.2) 38.0 - 44.6	n=25 42.4 ± 1.38 (42.4) 39.6 - 45.0
% of 50th percentile for head circumference (NCHS)§	n=18 101.0 ± 5.77 (101.1) 86 - 109	n=20 100.1 ± 4.55 (100.7) 90 - 108	n=25 99.3 ± 3.61 (99.0) 94 - 110	n=25 96.6 ± 3.14 (96.8) 90 - 103
Arm circumference, cm	n=20 9.3 ± 1.31 (9.9) 4.5 - 10.4	n=20 10.7 ± 1.08 (11.0) 8.0 - 12.9	n=22 11.9 ± 1.29 (11.9) 9.0 - 14.4	n=23 12.0 ± 1.26 (11.6) 9.6 - 14.4
Biceps skinfold, mm	n=20 3.9 ± 0.88 (4.0) 2.0 - 6.0	n=19 4.6 ± 1.52 (5.0) 2.0 - 8.0	n=21 6.0 ± 1.85 (5.5) 3.0 - 9.0	n=25 5.5 ± 1.75 (5.0) 3.0 - 9.0
Triceps skinfold, mm	n=20 5.3 ± 1.25 (5.0) 4.0 - 9.0	n=20 7.0 ± 3.02 (6.8) 2.0 - 13.0	n=22 8.8 ± 2.15 (9.0) 5.0 - 13.0	n=25 9.1 ± 2.16 (9.0) 4.0 - 12.0

* Mean ± SD

† Median

‡ Range

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Table 5.57.
Head circumference, arm circumference and skinfold thickness of female infants (cross-sectional data)

	Age of infant, months			
	Birth	1	3	6
Head circumference, cm	n=17 35.1 ± 1.01* (35.0)† 33.0 - 37.2‡	n=13 35.8 ± 1.50 (36.2) 33.0 - 38.4	n=19 38.8 ± 2.22 (39.1) 32.0 - 41.4	n=17 41.4 ± 1.44 (40.6) 39.2 - 45.0
% of 50th percentile for head circumference (NCHS)§	n=17 102.2 ± 2.94 (102.0) 96.0 -108.0	n=13 98.4 ± 4.06 (99.4) 91.0 -105.0	n=19 98.1 ± 5.61 (98.8) 81.0 -105.0	n=17 96.8 ± 3.41 (95.7) 92.0 -106.0
Arm circumference, cm	n=20 9.8 ± 0.89 (9.75) 8.2 - 12.0	n=15 10.5 ± 1.22 (10.4) 8.5 - 12.4	n=18 11.4 ± 1.17 (11.4) 8.5 - 13.6	n=17 12.3 ± 1.02 (12.0) 10.6 - 14.8
Biceps skinfold, mm	n=20 4.3 ± 1.22 (4.0) 2.0 - 6.5	n=15 4.9 ± 1.23 (5.0) 3.0 - 8.0	n=18 5.8 ± 1.60 (6.0) 3.0 - 9.0	n=17 5.8 ± 1.16 (6.0) 4.0 - 8.0
Triceps skinfold, mm	n=20 6.0 ± 1.47 (6.0) 3.0 - 8.0	n=15 6.4 ± 1.52 (6.0) 5.0 - 10.0	n=18 8.4 ± 1.54 (8.0) 6.0 - 11.0	n=17 9.9 ± 2.83 (9.5) 5.0 - 15.0

* Mean ± SD

† Median

‡ Range

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K. Morbidity of Infants

The number of illness episodes which were diagnosed and the mean duration and severity of the episodes are summarized in Table 5.58. Data are shown for 76 infants for whom the time observed was at least 90 days from birth to 6 months of age. The mean number of days observed over the 6-month period was 149 ± 25 (SD) which included 69 ± 16 days observed from birth to 3 months of age and 80 ± 19 days from 3 to 6 months. Over the entire observation period the mean number of illness episodes per infant was 5.9 with a mean duration of 6.2 days. The range of duration of illness from 1-130 days showed that some individuals experienced a particularly heavy burden of illness. Proportionate morbidity shown by category of illness (Table 5.58) indicated that the largest contributors to morbidity of infants were infectious diseases: digestive or gastro-intestinal (37.9% of all illnesses) and respiratory (31.8% of all illnesses). As expected, the single largest contributor to infant morbidity was diarrheal disease (25.8% of all illnesses) and the next largest contributor was bronchitis (19.3%). Eye and ear disorders combined comprised 17.4% of the illness episodes of infants, mostly attributed to conjunctivitis (12.7%). Skin problems with a mean duration of 12.2 days per episode represented 6% of the total illnesses diagnosed, the same percentage as fever (with and without other signs and symptoms) with a mean duration of 4.5 days per episode.

Table 5.58.
Morbidity diagnoses of infants from birth to 6 months of age

Diagnosis*	Episodes: Number	Duration, days mean (range)	% severe	% of category	% of total
Skin					
Impetigo	7	25.0 (4-130)	42.9	25.9	1.6
Cellulitis/abcess, boil	2	6.5 (6-7)	100.0	7.4	0.4
Fungus (ringworm)	2	7.0 (6-8)	0	7.4	0.4
Allergic or contact dermatitis	2	10.5 (8-13)	0	7.4	0.4
Burn	1	3.0	0	3.7	0.2
Other	13	8.0 (2-16)	0	48.1	2.9
Total	27	12.2 (2-130)	18.5	100.0	6.0
Eye					
Conjunctivitis	57	5.9 (2-20)	0	76.0	12.7
Stye/blepharitis	18	9.9 (3-33)	0	24.0	4.0
Total	75	6.9 (2-33)	0	100.0	16.7
Ear					
Otitis media	3	3.0 (2-4)	66.7	100.0	0.7
Mouth/teeth/gums					
Thrush	1	2.0	0	100.0	0.2
Respiratory					
Common cold	45	5.8 (1-15)	35.6	31.5	10.0
Tonsillopharyngitis	3	9.0 (4-15)	33.3	2.1	0.7
Bronchitis	87	6.3 (1-22)	100.0	60.8	19.3
Pneumonia	8	6.3 (2-16)	100.0	5.6	1.8
Total	143	6.2 (1-22)	78.3	100.0	31.8
Digestive					
Acute vomiting gastritis	38	4.6 (2-9)	100.0	22.4	8.4
Diarrheal disease	116	5.4 (1-22)	100.0	68.2	25.8
Dehydration	16	5.6 (2-15)	100.0	9.4	3.6
Total	170	5.2 (1-22)	100.0	100.0	37.9
Genito-urinary					
Infection	1	8.0	0	100.0	.2
Fever					
Fever - no other signs/symptoms	7	3.0 (2-6)	0	23.3	1.6
Fever - with other signs/symptoms	21	4.9 (2-12)	100.0	70.0	4.7
Fever - post immunization	2	5.5 (2-9)	0	6.7	.4
Total	30	4.5 (2-12)	70.0	100.0	6.7
Total	**449**	**6.2 (1-130)**	**69.5**		**100.2**
Mean per infant	5.9				

* Data for 76 infants observed for ≥90 days; mean 149 days ± 25 (SD)

The mean percentage of days ill, over at least a 90 day period of observation (mean ± SD of 149 ± 25 days) of 76 infants from birth to 6 months, was 4.6% for diarrhea and 6.0% for respiratory illnesses (Table 5.59). The range of percent days ill, 0-22.7% for diarrhea and 0-33.0% for respiratory illness, agreed with previous data that some individuals experienced a very heavy burden of illness. Less than 10% (7.9%) of the infants did not experience any illness other than skin problems (Table 5.59). More than one-third of the infants (36.8%) experienced illnesses 15% or more of the time observed. Approximately one-third of the infants observed experienced no diarrheal or respiratory illnesses (31.6 and 36.8%, respectively); however, a slightly higher percentage of infants experienced these illnesses 5% or more of the days observed (38.2% of days for diarrheal and 39.5% of days for respiratory illness).

The mean percent of time infants were ill at different ages from birth to 6 months of age and least squares means controlled for month of year are shown for all illnesses except skin, and for diarrheal and respiratory illnesses (Table 5.60). The mean burden of diarrheal illness of infants was greater from 3 to 6 months of age (range of 4.8-8.3% of time) than was observed at younger ages (1.2-1.9% of time). The effect of age on diarrheal illness was significant ($p<0.001$) when the least-squares means method was used to control for month of year (Table 5.61). The percent of time ill with diarrhea appeared to be greater from March through July (range of 4.7-10.7% of time ill) than from August through February (range of 0.7-4.3% of time ill) (Table 5.60). However, least-squares means controlled for age showed that month of year did not have a significant influence on the percent of time infants were ill with diarrhea (Table 5.61).

Mean percent of time infants were sick with respiratory illness exceeded that for diarrheal illness. Contrary to diarrheal illness, least-squares means controlled for month of year showed that older infants did not experience respiratory illness a significantly higher percentage of time than younger infants (Table 5.60). Respiratory illness followed a seasonal trend, i.e. percent of time ill was higher from December through March (7.6-10.4%) compared to other months (1.7-6.4%) and the low periods for respiratory illnesses were July and August. The effect of month of year on the percent of time sick with respiratory illness was significant ($p<0.009$) when least-squares means procedure was used to control for age (Table 5.61).

Table 5.59.
Percentage of time infants were ill with all illnesses (except skin ailments) and with diarrhea and respiratory illness from birth to 6 months of age

	Illness*		
	All except skin	Diarrhea	Respiratory
		% of days ill	
Mean ± SD	13.2 ± 9.9	4.6 ± 5.3	6.0 ± 7.6
Median	11.9	2.6	3.1
Range	0 - 42.9	0 - 22.7	0 - 33.0
% of time ill		% of infants	
None	7.9	31.6	36.8
<5	10.5	30.3	23.7
5-10	27.6	26.3	14.5
10-15	17.1	6.6	11.8
≥15	36.8	5.3	13.2

* Data for 76 infants

The general linear model approach to the estimation of infant morbidity by individual effect, age, and month of year estimated only about 32% of the variance in time ill without skin ailments, 27% of time ill with diarrhea, and 37% of time ill with respiratory illness (Table 5.61). The relatively small R^2 values and large coefficients of variation indicated the need for other analytical approaches.

L. Infant Mortality

Infant mortality was high in the study population; among 161 live born infants, 10 deaths occurred, 5 of these shortly after delivery (Table 5.62). Four of the deaths were on the day of delivery and one on the following day. Two of the infants who died were pairs of twins and another died following a complicated delivery. No other information about the deaths was available. Documentation of cause of death is not done in the village and parents, in many cases, were unwilling to discuss events which proceeded the death. Therefore, information about cause of death is sketchy. Among the 5 infants who survived for a longer postnatal period, two died from pneumonia, one at 6 days of age following a 3-day illness, the other at 20 days of age following a 2-day illness. At birth, the weights of both infants exceeded the 50% percentile of weight (NCHS), 104 and 120% of the median. The weight of one infant who died from fever at less than one month of age was only 76% of the 50% percentile of weight (NCHS) at birth. The infants who died at 2 and 4 months of age from unknown causes were 92 and 93% of median weight at the time of the last anthropometry measurements at 1 and 3 months, respectively. Household socioeconomic status was significantly lower ($p<0.05$) for families of the 10 infants who died compared to other families, but household sanitation scores were not significantly different. A follow up investigation of the infant population showed that 5 additional infants died before they reached one year of age. Household SES for the 15 infants who died during or following the study was significantly poorer ($p<0.004$) than that of the other households (3.47).

Table 5.60.
Means and least-squares means of percent of time infants were ill at different ages and months of year from birth to 6 months

		Illness		
	n	All except skin	Diarrhea	Respiratory
Age, month			**% of time ill**	
1	82	6.7 ± 6.8*	1.2 ± 7.6	5.1 ± 15.7
2	81	10.5 ± 16.8	1.9 ± 6.3	6.8 ± 13.6
3	80	10.6 ± 15.9	4.8 ± 11.6	5.3 ± 10.8
4	80	14.4 ± 19.8	3.9 ± 10.4	5.8 ± 13.9
5	80	15.5 ± 23.2	8.3 ± 20.3	4.7 ± 11.3
6	77	18.5 ± 19.6	6.1 ± 11.1	8.1 ± 15.7
1		6.3 ± 2.1*,†	1.0 ± 1.4	5.0 ± 1.5
2		11.0 ± 2.1	1.9 ± 1.4	6.7 ± 1.5
3		11.0 ± 2.1	4.8 ± 1.4	4.4 ± 1.5
4		14.8 ± 2.1	4.0 ± 1.4	5.2 ± 1.5
5		16.1 ± 2.1	9.0 ± 1.4	4.1 ± 1.5
6		18.3 ± 2.2	6.1 ± 1.5	7.7 ± 1.5

Table 5.60. continued

	n	Illness		
		All except skin	Diarrhea	Respiratory
Month of year			**% of time ill**	
January	54	11.4 ± 21.2*	2.4 ± 12.1	8.5 ± 18.1
February	56	11.9 ± 17.0	2.4 ± 8.6	10.4 ± 17.2
March	48	15.1 ± 18.5	7.6 ± 15.3	8.1 ± 14.6
April	47	12.7 ± 15.3	4.7 ± 9.9	5.2 ± 11.0
May	42	18.6 ± 19.0	6.9 ± 13.8	4.9 ± 10.7
June	32	23.8 ± 29.9	10.7 ± 19.9	6.4 ± 16.8
July	23	17.6 ± 25.0	8.3 ± 22.2	1.7 ± 8.2
August	22	10.4 ± 17.8	0.7 ± 2.9	1.8 ± 5.3
September	36	9.8 ± 14.3	4.3 ± 9.5	2.5 ± 8.9
October	37	7.8 ± 16.2	3.0 ± 8.4	3.2 ± 9.7
November	37	5.3 ± 11.0	1.3 ± 5.0	3.3 ± 8.0
December	46	9.9 ± 18.1	1.8 ± 8.1	7.6 ± 16.2
January		13.3 ± 2.5*,‡	2.5 ± 1.7	9.9 ± 1.8
February		12.2 ± 2.5	2.0 ± 1.7	11.1 ± 1.7
March		13.6 ± 2.7	6.3 ± 1.9	8.5 ± 1.9
April		9.7 ± 2.9	2.9 ± 1.9	5.7 ± 1.9
May		12.4 ± 3.1	3.7 ± 2.1	4.3 ± 2.2
June		16.2 ± 3.6	7.3 ± 2.4	4.7 ± 2.5
July		14.1 ± 4.0	7.1 ± 2.7	0.5 ± 2.8
August		10.1 ± 4.1	2.2 ± 2.7	0.01 ± 2.9
September		15.1 ± 3.4	8.1 ± 2.3	1.9 ± 2.4
October		14.0 ± 3.4	6.2 ± 2.3	4.1 ± 2.3
November		11.5 ± 3.3	2.4 ± 2.2	6.4 ± 2.3
December		12.8 ± 2.8	2.8 ± 1.9	9.0 ± 2.0

* Mean ± SD

† Least-squares means controlled for month of year

‡ Least-squares means controlled for age of infant

Table 5.61.
General linear models estimating infant morbidity by individual effect, age, and month of year

Independent variable	df	Type I sums of squares	F	p
A. Dependent variable: Percent of time ill excluding skin ailments				
ID	85	4.83	1.8	<0.0001
Age of infant	5	0.73	4.7	<0.0004
Month of year	11	0.13	0.4	<0.96 (NS)
R^2	=	0.32		
Root mean square error	=	0.18		
Coefficient of variation	=	140		
B. Dependent variable: Percent of time ill with diarrhea				
ID	85	1.42	1.2	<0.12 (NS)
Age of infant	5	0.28	4.1	<0.001
Month of year	11	0.20	1.3	<0.22 (NS)
R^2	=	0.27		
Root mean square error	=	0.12		
Coefficient of variation	=	272		
C. Dependent variable: Percent of time ill with respiratory illness				
ID	85	2.74	2.2	<0.0001
Age of infant	5	0.07	1.0	<0.43 (NS)
Month of year	11	0.38	2.3	<0.009
R^2	=	0.36		
Root mean square error	=	0.12		
Coefficient of variation	=	207		

Table 5.62.
Relationship of infant mortality to prior morbidity and anthropometry

Infant	Cause of death	Age at death	Prior morbidity Diagnosis	Duration	Age	Severe	Last body weight measurement
				days	days		% of median weight (NCHS)
A-D	Perinatal*	1 day					
E	Perinatal*	2 days					
F	Pneumonia	6 days	Bronchitis	3	3-6	Yes	120 (Birth)†
G	Pneumonia	20 days	Pneumonia	2	18-19	Yes	104 (Birth)
H	Fever	≤1 mo					76 (Birth)
I	Unknown	2 mo					93 (1 mo)
J	Unknown	4 mo	Common cold	4	74-78	Yes	92 (3 mo)
			Conjunctivitis	4	88-92	No	

* Infant A was a twin delivered by Caesarian section; Infant B was a twin whose counterpart was low birth weight; Infant C was delivered following complicated labor; Infants D and E, no additional information was available.
† Age of last measurement

M. Relationship of Different Variables To Infant Weight At 6 Months of Age

1. Maternal Literacy and Household Variables

Maternal literacy and years of formal education were not directly and significantly related to infant weight at 6 months of age; however only 15 of 81 mothers in the study group were literate resulting in a disproportionately small number of mothers in the literate group. Infants from households classified as low socioeconomic status, weighed significantly less ($p<0.05$) at 6 months of age than infants from households in the upper/intermediate and high SES categories (Table 5.48).

Household sanitation index correlated negatively and significantly ($R^2=0.10$, $p<0.005$) with the percent of time infants were ill with diarrhea (Figure 5.25) which in turn significantly ($p<0.005$) affected infant weight at 6 months. Household sanitation was also associated with several maternal and household variables which in turn influenced infant morbidity and infant weight at 6 months. Simple regression analyses showed that households classified as higher SES and those with more educated lead females rated higher in household sanitation than those of lower SES or poorly educated mothers (Table 5.63). Also maternal food intake during lactation, particularly animal protein intake, was an important variable related to household sanitation (Table 5.63). Maternal iron status, assessed by plasma ferritin and hemoglobin levels, was positively related to household sanitation (Table 5.63), possibly due to some association of iron nutriture with work performance of the mother. A summary of the variables related to household sanitation by simple regression analyses and in turn to infant morbidity and weight at 6 months are shown in Figure 5.26. These variables are discussed again in a subsequent section of this report, which shows multiple regression models predicting household sanitation.

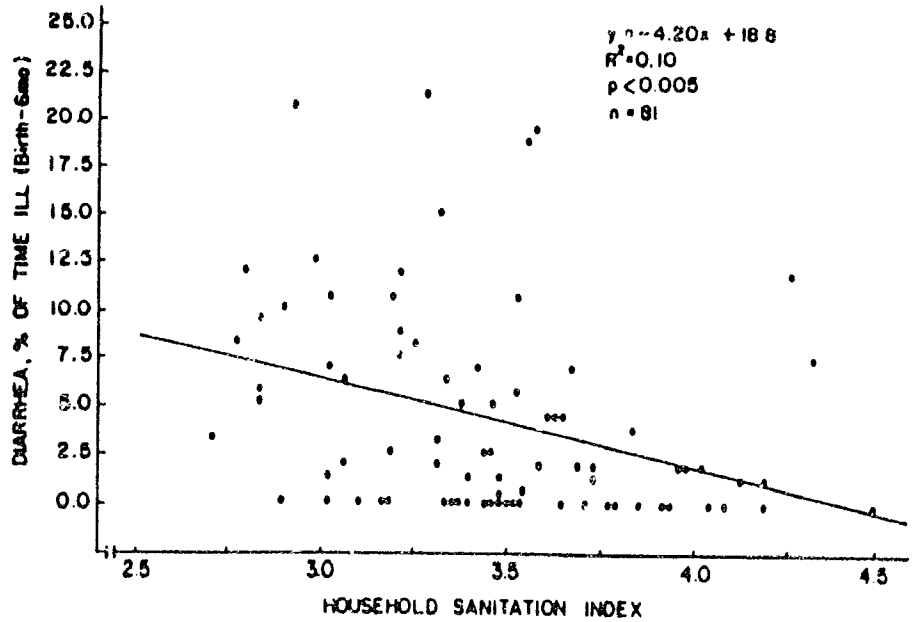


FIG 5.25. Relationship of household sanitation index to percent of time infants were ill with diarrhea

2. Maternal Food Intake

Maternal mean energy intake (total kcal/day) during the first 6 months of lactation (Figure 5.27) was significantly related to infant weight at 6 months of age, expressed as percent of the 50th percentile (R^2 =0.12, p<0.003). Maternal energy intake from only fat and carbohydrate sources (kcal/day) also had a significant effect (R^2=0.13, p<0.001) on infant weight at 6 months (Figure 5.27). Maternal plant protein intake, which had a significant effect on infant weight at 6 months (R^2=0.09, p<0.009), appeared to be a proxy for energy intake. Neither maternal total protein nor animal protein intakes from 0 to 6 months, were related significantly to infant weight (Figure 5.27). Multiple regression models for predicting infant weight at 6 months of age (Section O) showed that the best two-variable model included either the diarrhea or SES variable and maternal plant protein intake (g/day) during the first 6 months of lactation. In other models, the use of either maternal plant protein intake or energy intake for predicting weight at 6 months did not change the predictive power. Clearly maternal energy and/or plant protein intake during lactation were associated with infant weight at 6 months of age.

Table 5.63.
Relationship of certain household and maternal variables to household sanitation by simple regression analyses

Independent variable	n	Regression coefficient	SE	p	R^2
Household					
Socioeconomic status*	107	-1.17	0.03	0.0001	0.18
Intercept		3.90	0.11		
Mother					
Education, yrs	107	0.04	0.02	0.04	0.04
Intercept		3.39	0.04		
Food intake, 0-6 mo postpartum					
Kcal/d	90	0.00007	0.00001	0.65(NS)	0.002
Intercept		3.30	0.32		
Total protein, g/d	90	0.006	0.003	0.06	0.04
Intercept		3.01	0.23		
Animal protein, g/d	90	0.01	0.003	0.002	0.11
Intercept		3.12	0.11		
Plant protein, g/d	90	-0.01	0.006	0.06	0.04
Intercept		3.91	0.25		
Hematology, 0-3 mo postpartum					
Hemoglobin, g/dl	62	0.06	0.03	0.07	0.06
Intercept		2.75	0.37		
Ferritin, ug/dl	57	0.005	0.002	0.05	0.07
Intercept		3.28	0.08		

* 1=high and 4=low SES groups

3. Maternal Anthropometry

Several parameters of maternal anthropometry from 0 to 6 months postpartum were examined relative to infant weight at 6 months of age expressed as percent of the 50th percentile. Among the maternal parameters examined, height and arm circumference were significantly related to infant weight at 6 months (R^2 =0.05, $p<0.05$ and R^2=0.09, $p<0.03$, respectively). Upper arm circumference measurements, which were also significantly related to birth weight, can be performed with the use of a simple measuring tape, whereas equipment needed for other anthropometric measurements may not be readily available in rural village settings. Maternal bicep skinfold thickness at 6 months postpartum and the change in skinfold thickness from 0-6 months lactation also tended to be related to infant growth, % of 50th percentile of weight at 6 months of age (R^2=0.07, $p<0.06$ and R^2=0.12, $p<0.06$, respectively).

The significant relationship between infant weight at 6 months and maternal anthropometric measurements at 6 months postpartum appeared to be through an indirect effect of these variables on birth weight. Mothers who were heavier in weight in early pregnancy delivered heavier infants and were heavier in weight at 6 months postpartum than mothers who began their pregnancies with lower body weights. Furthermore, regression analysis discussed in the next section showed a significant positive relationship between birth weight and infant weight at 6 months of age.

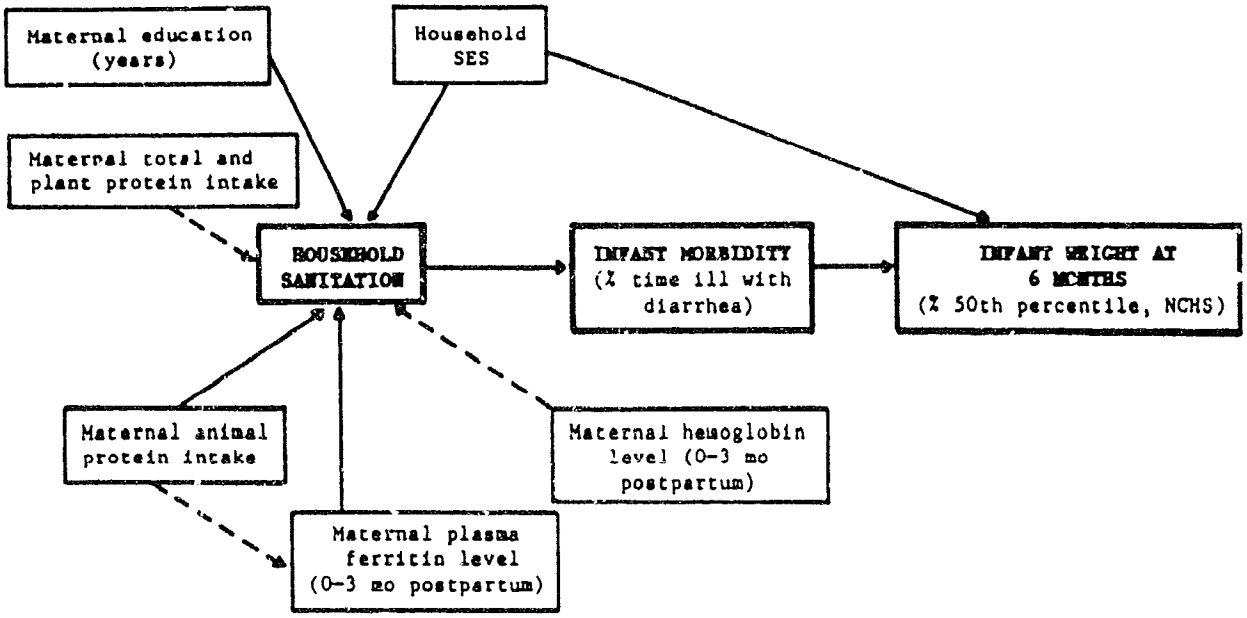


FIG 5.26. Summary of variables related to household sanitation and the relationship of these to infant morbidity and weight at 6 months by simple regression analyses. ——— significant effect ($p<0.05$); - - - trend ($p<0.01$)

4. Birth Weight

Birth weight was significantly related to subsequent weights through 6 months of age as shown by the data in Table 5.64. However, birth weight and weight at 8 days were poorer predictors of subsequent weights than weights at 1 month and later. The Pearson correlation coefficient of birth weight with weight at 6 months was $r=0.39$ ($p<0.0006$), whereas the relationship of weights at 3 to 5 months with subsequent weights resulted in coefficients of $r=0.79$, 0.88 and 0.92 ($p<0.0001$), respectively. The relationship of weight expressed as percent of the 50th percentile (NCHS) to subsequent weight was similar to the findings with weight per se (Table 5.64).

Birth weight expressed as percent of the 50th percentile of weight (NCHS) was significantly and negatively ($R^2=0.32$, $p<0.0001$) related to change in weight percentiles from birth to 6 months of age (Figure 5.28). Most infants decreased in weight percentiles during the first 6 months; this change was more evident among infants who were in the higher percentiles at birth. Infants who were in low percentiles for weight at birth generally showed small gain in percentiles by 6 months of age. One suggestion from a previous study (11) is that mothers fostered attention on small infants, including more frequent breast feeding, which promoted an improved weight status.

FIG 5.27 Relationship of maternal total energy intake, energy intake from fat and carbohydrate, and animal and plant protein intake during the first 6 months of lactation to infant weight at 6 months of age.

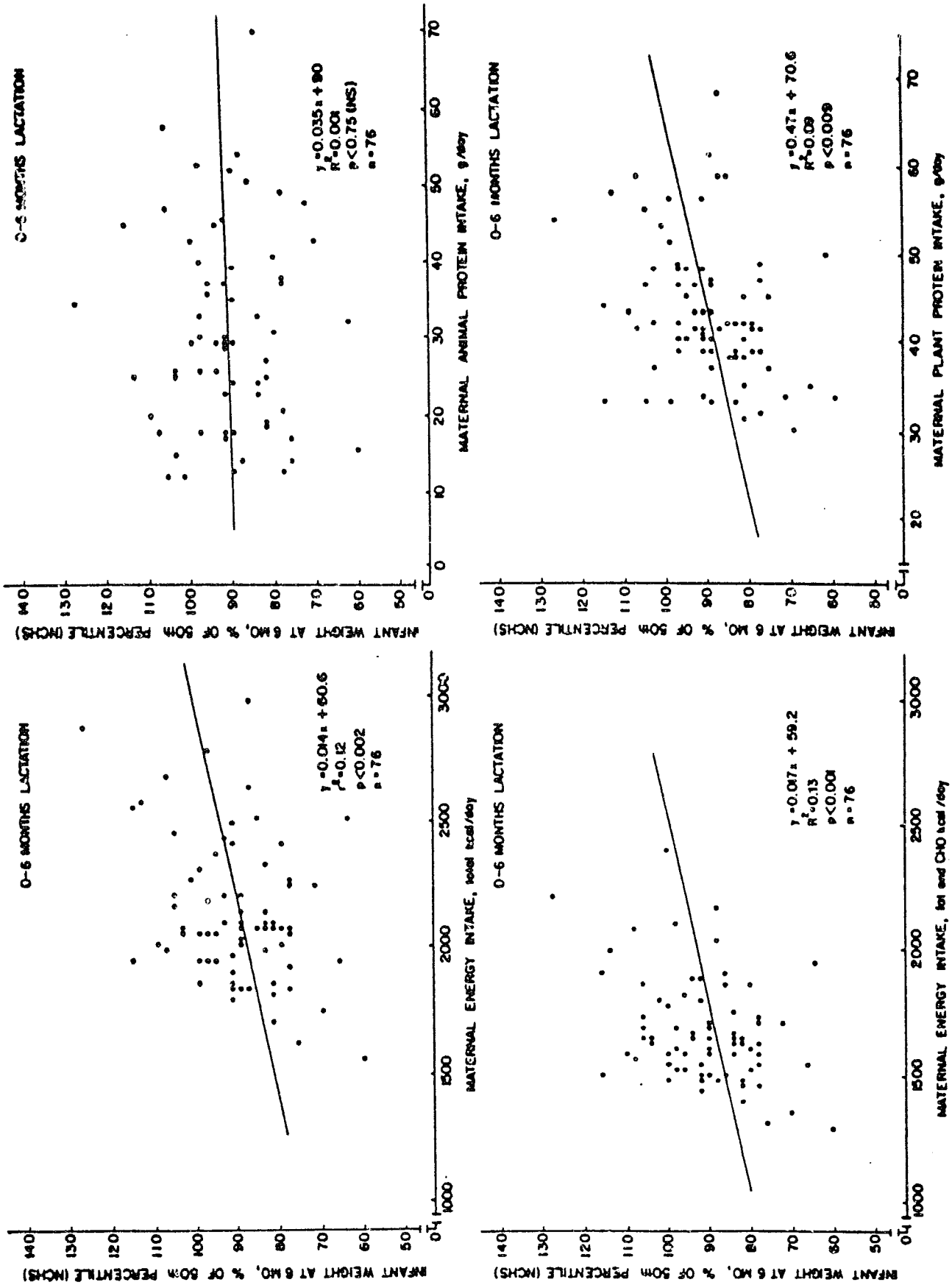


Table 5.64.
Relationship of infant weight to subsequent weights from birth to 6 months of age

Month	Age of infant, months						
	8(day)	1	2	3	4	5	6
				Weight, g			
Birth	0.89* 0.0001† 90‡	0.69 0.0001 84	0.52 0.0001 78	0.58 0.0001 76	0.50 0.0001 74	0.43 0.0002 72	0.39 0.0006 74
8(day)		0.75 0.0001 87	0.64 0.0001 83	0.63 0.0001 79	0.58 0.0001 77	0.50 0.0001 75	0.47 0.0001 76
1			0.88 0.0001 89	0.84 0.0001 85	0.78 0.0001 83	0.61 0.0001 81	0.60 0.0001 83
2				0.93 0.0001 85	0.89 0.0001 83	0.76 0.0001 81	0.73 0.0001 81
3					0.94 0.0001 84	0.83 0.0001 82	0.79 0.0001 82
4						0.92 0.0001 81	0.88 0.0001 81
5							0.92 0.0001 79
		Weight, % of 50th percentile (NCHS)§					
Birth		0.68* 0.0001 84		0.55 0.0001 76			0.36 0.002 74
1				0.83 0.0001 85			0.58 0.0001 83
3							0.76 0.0001 82

* Pearson correlation coefficient (r)

† Statistical significance ($p<0.05$)

‡ Number of infants

§ National Center for Health Statistics

Among a group of 74 infants examined, more than one-half (38 infants) were at or above the NCHS 50th percentile at birth (Figure 5.29). At 6 months of age, 9 of the 38 infants were still above average weight, but three-fourths (29) had dropped below the average weight percentile (63 to 99.9% of the 50th percentile). At 6 months of age, 60 infants or 81.1% of the total group of 74 were below the 50th percentile for weight and only 14 (18.9%) were above the median weight. Among these 14 infants, 9 exceeded the 50th percentile for weight at birth and 5 were below with a range of 85 to 99.7% (Figure 5.29).

In order to analyze infant growth and weight at 6 months in further detail, infants were classified into three categories on the basis of their weights at 6 months (Table 5.65). Growth and morbidity of infants as well as several maternal and household variables were compared retrospectively among the three groups of infants. Infants who were in the highest weight category at 6 months had significantly higher birth weights and were from households of higher socioeconomic status compared to infants who were in the lowest weight category at 6 months. Infants in the highest and middle weight categories at 6 months were comparable in weight at birth and at one month, but after 3 months, weights of the infants in these two categories differed significantly. Infants in the highest weight group were less sick with diarrhea and received fewer food supplements over the 6 months compared to infants in the other two groups. However, the differences failed to reach statistical significance (Table 5.65). Maternal energy and protein intakes were similar among the three groups. Explanations for these observations of the relationship of birth weight percentiles to subsequent weight percentiles remain speculative but could relate in part to child care.

5. Infant Morbidity

Mean percent of time infants were sick with all illnesses except skin problems was significantly and inversely related (R^2=0.07; $p<0.05$) to infant weight at 6 months of age (Figure 5.30). In particular, the percent of time ill with diarrhea impacted negatively (R^2=0.14; $p<0.005$) on infant weight at 6 months of age. Two infants whose weights were less than 75% of the median percentile at 6 months (NCHS) were ill with diarrhea more than 20% of the time observed whereas three infants whose weights were approximately 115% of the median at 6 months (NCHS) were ill only 0-2% of time observed. The negative impact of illness, especially diarrhea, on infant growth at 6 months of age was not unexpected. Multiple regression models for the prediction of infant weight at 6 months (Section O) indicated that the diarrhea variable was the single best predictor. Clearly, morbidity of the infant was associated with weight of the infant at 6 months.

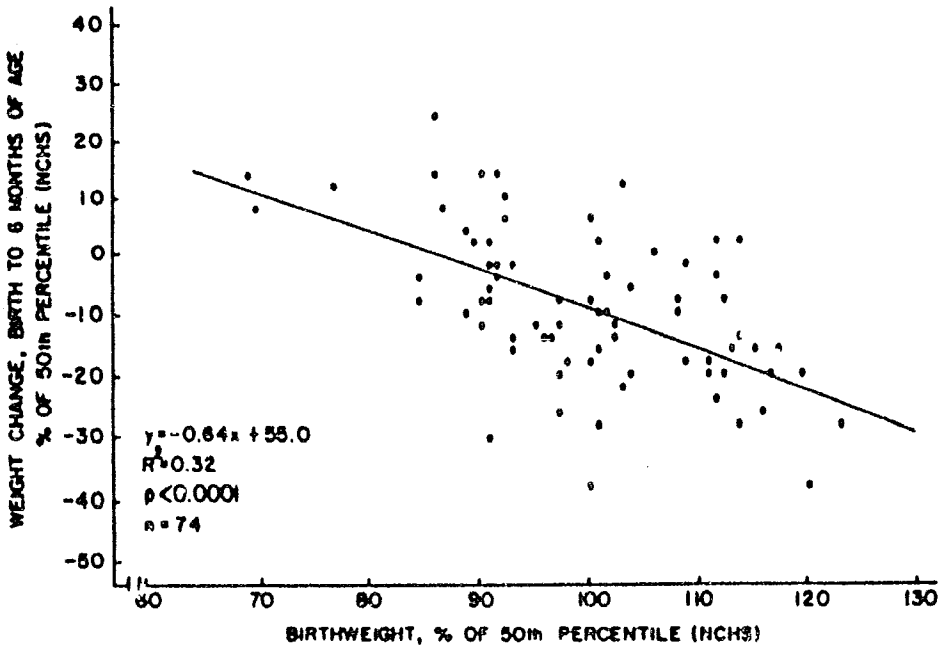


FIG 5.28. Relationship of birthweight expressed as % of 50th percentile (NCHS) to change in weight percentile from birth to 6 months of age

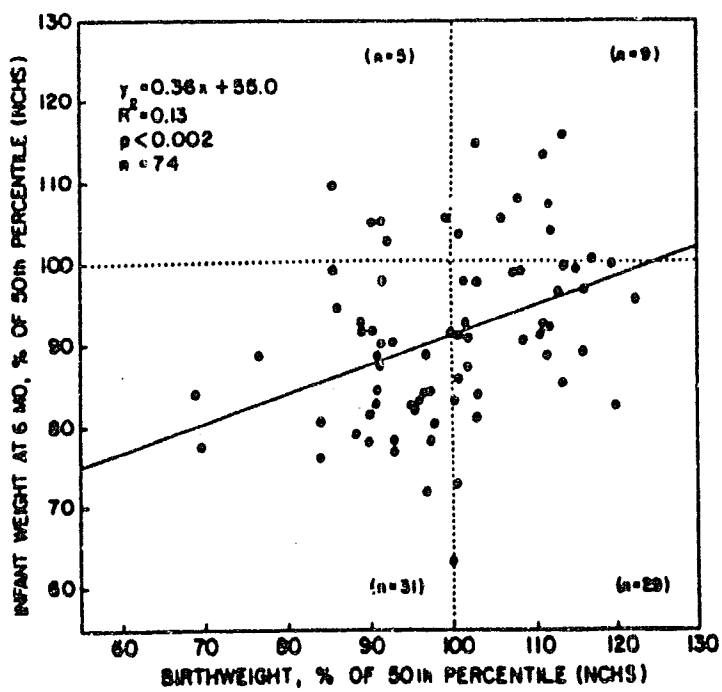


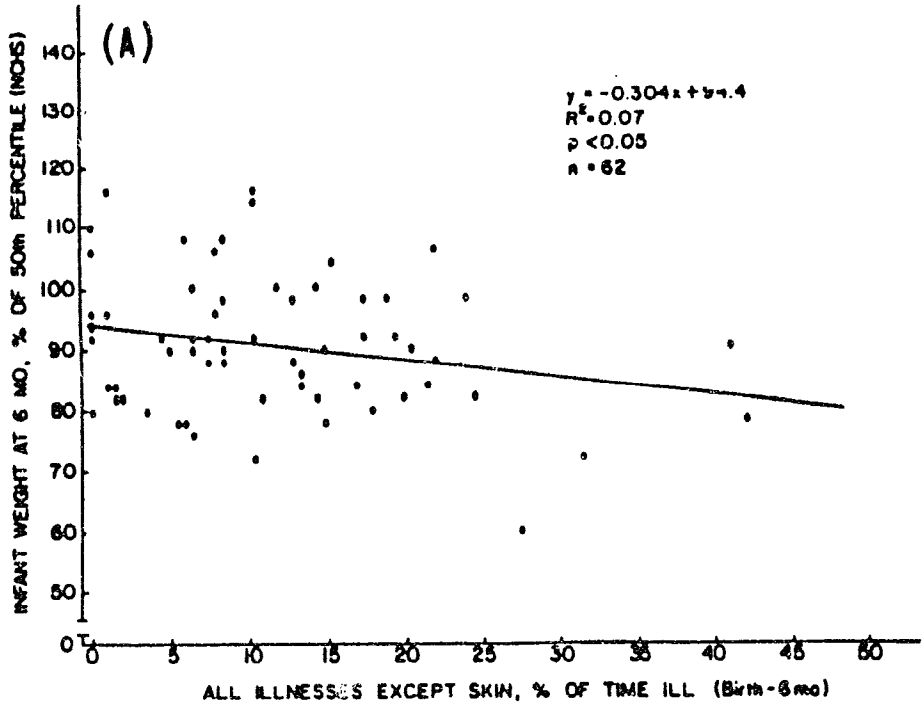
FIG 5.29. Relationship of birthweight and weight at 6 months of age, both expressed as % of 50th percentile (NCHS)

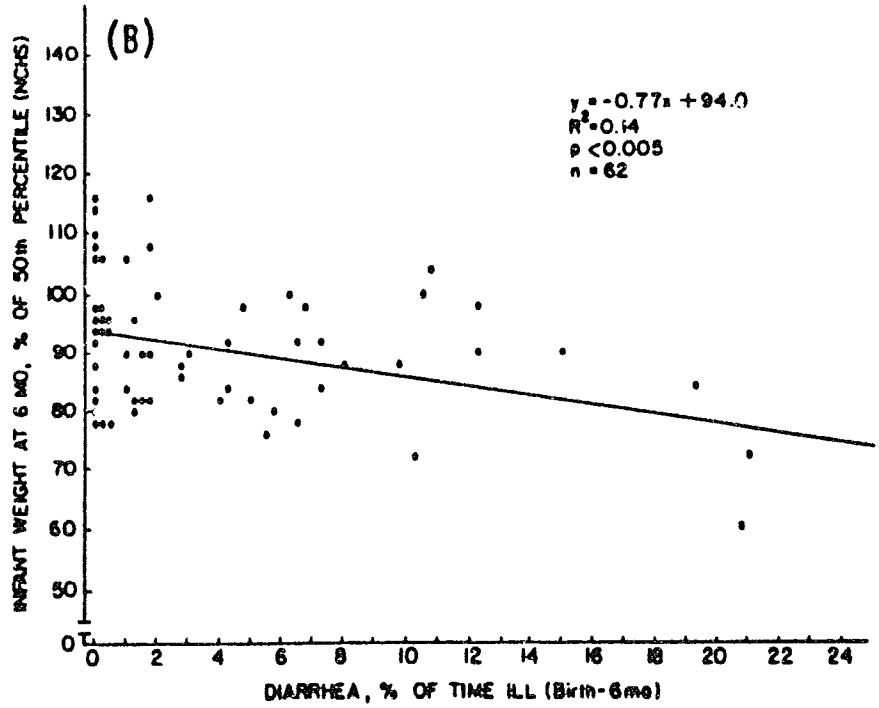
Table 5.65.
Comparison of growth, morbidity, and selected variables for infants classified into three categories of weight at 6 months

	Classification of infant weight at 6 months % of 50th percentile (NCHS)*		
	<90	90-100	>100
Infant weight	(n=34)	(n=26)	(n=14)
		% of 50th percentile	
Birth	95.2 ± 11.1[†,‡]	103.2 ± 10.9[§]	103.1 ± 10.0[§]
	69 -120[‡‡]	86 - 123	85 - 117
1 month	94.6 ± 10.4[‡]	107.3 ± 10.8[§]	106.8 ± 9.9[§]
	71 - 115	90 - 138	89 - 124
3 months	90.6 ± 10.0[‡]	103.3 ± 8.5[‡]	109.6 ± 8.5**
	69 - 108	84 - 126	96 - 124
6 months	80.9 ± 6.6[‡]	94.4 ± 3.5[§]	107.2 ± 4.8**
	60 - 89	90 - 99.9	100 - 116
		Change in % of 50th percentile	
0 to 6 months	-14.2 ± 12.0[‡]	- 8.7 ± 10.3[‡]	4.1 ± 10.4[§]
	-37.7 - 14.8	-27.1 - -13.4	-16.6 - 24.0
	(n=28)	(n=23)	(n=11)
		% time sick	
Diarrheal illness	5.09± 6.2	3.76± 4.73	1.95± 3.44
0 to 6 months	0 - 21.0	0 - 14.9	0 - 10.7
Respiratory illness	6.09± 6.9	4.16± 5.94	4.67± 6.65
0 to 6 months	0 - 24	0 - 19	0 - 22
Supplementation	(n=28)	(n=20)	(n=11)
		Number of foods	
0 to 3 months	0.82± 1.19	0.55± 0.89	0.36 ± 0.92
	0 - 4	0 - 3	0 - 3
3 to 6 months	2.86± 3.60	3.40± 5.11	1.73± 1.79
	0 - 14	0 - 22	0 - 5
0 to 6 months	3.68± 4.29	3.95± 5.11	2.09± 2.30
	0 - 17	0 - 22	0 - 6
Household			
Sanitation index	3.40± 0.43	3.44± 0.40	3.42± 0.41
	2.69- 4.30	2.74- 4.48	2.66- 4.18
Socioeconomic status[††]	3.12± 0.91[‡]	2.65± 1.09[‡,§]	2.21± 0.70[§]
	1 - 4	1 - 4	1 - 4
Maternal food intake, 0-6 months	(n=29)	(n=25)	(n=13)
Animal protein, g/day	32.1 ± 14.4	31.1 ± 10.4	29.5 ± 16.3
	13 - 70	13 - 53	12 - 58
Plant protein, g/day	41.8 ± 8.4	43.1 ± 6.2	45.5 ± 8.6
	31 - 68	33 - 56	33 - 59
Kcal/day	2105 ± 309	2123 ± 312	2229 ± 244
	1572 - 2949	1800 - 3122	1936 - 2661

* National Center for Health Statistics; † Mean + SD; ‡-** Means in rows with different superscripts differ significantly ($p<0.05$); †† 1=high and 4=low SES groups, ‡‡ Range

FIG. 5.30. Relationship of percent of time infants were sick with all illnesses except skin problems (A) and with diarrhea (B) to their weight at 6 months of age





6. Supplementary Food Intake

Data for the supplementary food intake of infants at different ages during the first 6 months are summarized in Table 5.66. All infants received water and sugar throughout the 6 months and approximately one-third of the infants were fed rice water. The percentage of infants fed supplementary foods, with the exception of water and sugar, sugary concoctions and rice water, increased from 8% at 1 month of age to 27% at 3 months and 46% at 6 months. Over the 6 month period observed, 28% of the infants did not receive any supplements other than water and sugar, sugary concoction, and rice water.

Data showing the influence of the age of introduction of supplementary foods on infant weight expressed as percent of the 50th percentile and as change in weight percentiles from 0-3, 3-6 and 0-6 months of age are shown in Table 5.67. Sugar water, sugary concoctions, and rice water, which were widely used as supplements, were excluded from these analyses. Infants who were supplemented tended to fall in somewhat lower weight percentiles at 6 months of age and to show greater losses in percentiles for weight than unsupplemented infants. However, the only significant difference in weight which was associated with supplementation was for the infants supplemented during the period from 0-3 months. Weights of these infants expressed as percent of the 50th percentile (NCHS) at 3 months were significantly less ($p<0.05$) than those of infants who were not supplemented. Simple regression analyses showed an R^2 of 0.09, i.e. 9% of the variance in infant weight at 3 months was significantly associated with early supplementation (Table 5.68).

Infants who were supplemented early, i.e. from 0-3 months of age, tended to be from households of higher SES ($p<0.05$) (Table 5.69). Otherwise, neither the age of supplementation nor the type of supplements introduced, i.e. milk, legumes, vegetables, at different ages, was significantly different among the different categories of household SES. Multiple regression analysis of SES and age of introduction of supplements with infant weight at 3 months expressed as percent of the 50th percentile (NCHS) resulted in an R^2 of 0.13 and was only slightly higher than the R^2 (0.09) for the simple regression of age of introduction of supplements with infant weight (Table 5.68). However, after 3 months of age, household SES was the important variable which influenced infant weight, whereas age of supplementation did not have a significant effect.

There was a tendency ($p<0.10$) for all illnesses except skin ailments at 6 months of age to be higher among the supplemented group than the non-supplemented group but the type of illness, i.e. diarrheal or respiratory illness was not significantly different between the two groups (Table 5.70). The number of food supplements offered to infants did not significantly influence their morbidity (% of days ill) or mean weight at 6 months of age.

Simple regression analyses of all of the independent variables, discussed in Section M, with infant weight at 6 months, expressed as percent of the 50th percentile, are summarized in Table 5.71.

Table 5.66.
Percent of infants fed various supplementary foods at different ages during the first 6 months

Supplementary food	Age of infant, months					
	1 (99)*	2 (95)	3 (91)	4 (90)	5 (87)	6 (91)
	% of infants					
Water and sugar	100	100	100	100	100	100
Sugary concoction	35	5	7	-	11	7
Rice water	37	43	36	30	29	22
Water	-	-	-	-	-	1
Soft drinks	1	-	3	4	11	9
Tea	-	-	-	2	1	7
Orange/tomato juice	-	-	-	1	-	-
Cow milk (fresh)	-	-	-	-	-	1
Skim milk	3	6	8	9	13	9
Powdered milk	-	-	1	3	-	-
Full cream cheese	2	9	12	8	7	9
Processed cheese	-	-	-	-	2	1
Yogurt	-	-	-	-	-	1
Mehallabia†	1	6	5	10	13	9
Supramine‡	-	-	-	2	8	9
Biscuits	-	-	-	-	-	1
Bread	-	-	-	-	7	12
Rice	-	-	-	-	-	4
Sprouted beans	-	-	-	1	3	4
Stewed beans	-	-	-	3	3	15
Other legumes	-	-	-	-	2	1
Cooked vegetables	1	-	-	-	-	-
Fresh vegetables	-	-	-	1	5	5
Eggs	-	-	1	2	-	1
Rabbit	-	-	-	-	1	-
Sesame cake§	-	-	-	1	7	11
Other cakes and sweets	-	1	2	1	-	-
Fats/oils	-	-	-	1	-	4
Not supplemented**	92	79	73	63	60	54

* Number of infants; † Mixture of approximately 20g cornstarch, 10g sugar and 200 ml water heated to a thick consistency and cooled; ‡ The Nile Company, Cairo, Egypt (composition by wt %: chick peas, 31.5; wheat flour, 23.1; powdered milk, 20.0; lentils, 15.4; sucrose 8.0; and minerals and vitamins, 2.0); § Most of the oil is extracted from sesame seeds leaving a residue to which sugar is added; ** Water and sugar, sugary concoction, and rice water excluded; †† 1-6 month period.

Table 5.67.
Influence of age of supplementation on infant weight from birth to 6 months of age

Age of infant	Age of infant: 0-3 months		3-6 months		0-6 months	
	Supplemented* n=20	Not Supplemented n=39	Supplemented n=41	Not Supplemented n=18	Supplemented n=42	Not Supplemented n=17
			Weight, % of 50th percentile (NCHS)			
Birth	97.0 ± 10.6†	100.4 ± 12.2	99.4 ± 11.5	98.9 ± 12.5	99.3 ± 11.3	99.0 ± 12.9
	84 - 120‡	69 - 123	69 - 120	70 - 122	69 - 120	69 - 123
3 months	94.6 ± 11.4§	101.1 ± 10.8§	98.1 ± 12.1	100.8 ± 9.5	98.2 ± 12.0	100.6 ± 9.7
	69 - 109	80 - 124	69 - 124	80 - 117	69 - 124	80 - 117
6 months	87.8 ± 10.8	91.9 ± 12.4	89.6 ± 12.4	92.5 ± 11.1	89.6 ± 12.2	92.7 ± 11.4
	60 - 104	63 - 116	60 - 116	77 - 115	60 - 116	77 - 115
			Change in weight % of 50th percentile for weight (NCHS)			
0-3 months	-2.4 ± 10.0	0.8 ± 9.1	-1.3 ± 10.1	1.9 ± 7.4	-1.1 ± 10.1	1.6 ± 7.5
	-21.2 - 13.6	-17.1 - 20.7	-21.2 - 20.7	-9.5 - 17.0	-21.2 - 20.7	-9.5 ± 17.0
3-6 months	-6.9 ± 8.2	-9.2 ± 7.2	-8.5 ± 7.6	-8.3 ± 7.9	-8.6 ± 7.5	-7.9 ± 7.9
	-22.3 - 8.0	-22.6 - 7.0	-22.6 - 8.0	-18.9 - 7.0	-22.6 - 8.0	-18.9 - 7.0
0-6 months	-9.23 ± 13.0	-8.5 ± 13.4	-9.7 ± 13.0	-6.4 ± 13.7	-9.7 ± 12.8	-6.3 ± 14.1
	-37.7 - 13.4	-37.0 - 24.0	-37.7 - 14.8	-27.1 - 24.0	-37.7 - 14.8	-27.1 - 24.0

*Including sugar water, sugary concoctions, and rice water

†Mean ± SD

‡Range

§Means in columns with different superscripts differ significantly ($p<.05$)

Table 5.68.
Relationship of the age of introduction of food supplements and household socioeconomic status (SES) to infant weight expressed as percent of the 50th percentile (NCHS)

Dependent variable	Independent variable	n	Regression coefficient	SE	p	R^2
			Simple regressions			
Infant weight, % of 50th percentile (NCHS)*	Age of introduction of supplements					
3 months	0-3 months	[illegible]	-3.4	1.31	0.01	0.09
	Intercept		100.3		1.65	
6 months	3-6 months	66	0.09	0.39	0.82(NS)	0.0008
	Intercept		89.6	1.88		
6 months	0-6 months	66	-0.08	0.35	0.81(NS)	0.0009
	Intercept		90.2		1.95	
			Multiple regressions			
3 months	Supplements introduced, 0-3 months	68	-3.87	1.32	0.01	0.13
	Household SES†		-2.22	1.44	0.13(NS)	
	Intercept		106.8	4.5		
6 months	Supplements introduced, 3-6 months	66	0.08	.38	0.82(NS)	0.09
	Household SES		-3.74	1.46	0.01	
	Intercept		100.0		4.45	
6 months	Supplements introduced, 0-6 months	66	-0.14	0.34	0.80(NS)	0.10
	Household SES		-3.78	1.47	0.01	
	Intercept		100.8	4.5		

* National Center for Health Statistics

† 1=high and 4=low SES groups

Table 5.69.
Relationship of household socioeconomic status to the total number and types of supplements introduced to infants from birth to 6 months of age

Age of infant, months	Household socioeconomic status: High n=11	Upper intermediate n=8	Lower intermediate n=33	Low n=16
		Total number of supplements*		
0-3	1.3 ± 1.2†,§ 0 - 3‡	1.0 ± 1.4§,** 0 - 4	0.4 ± 0.8** 0 - 3	0.7 ± 1.2§,** 0 - 4
3-6	3.6 ± 3.0 0 - 9	3.1 ± 3.0 0 - 9	2.0 ± 3.3 0 -14	3.8 ± 5.3 0 -22
0-6	4.9 ± 3.5 0 -11	4.1 ± 4.2 0 -13	2.4 ± 3. 7 0 -17	4.4 ± 5.3 0 -22
		Number of milk and weaning foods		
3-6	1.6 ± 1.6 0 - 4	2.0 ± 2.0 0 - 5	1.0 ± 1.7 0 - 5	1.1 ± 1.8 0 - 6
		Number of legumes and vegetables		
3-6	0.5 ± 1.0 0 - 3	0.3 ± 0.7 0 - 2	0.3 ± 0. 7 0 - 2	0.7 ± 2.0 0 - 8

* Excluding sugar water, sugary concoctions, and rice water

† Mean ± SD

‡ Range

§,** Means with different superscripts differ significantly ($p<.05$)

Table 5.70.
Comparison of the morbidity of breast fed infants who were supplemented and not supplemented at 1, 3 and 6 months of age

	Age of infant					
	1 month		3 months		6 months	
Illness†	Supplement* n=5	No supplement n=62	Supplement n=19	No supplement n=47	Supplement n=27	No supplement n=39
			Number of days ill			
All except skin problems	1.0± 2.24‡	1.6± 4.32	2.6± 3.42	2.2± 3.7 8	7.6± 6.45	5.0± 5.88 p<0.10
Diarrheal	0.0± 0.00	0.4± 2.52	0.8± 1.90	0.8± 2.15	2.1± 4.06	2.5± 4.60
Respiratory	1.0± 2.23	1.2± 3.96	1.3± 2.83	1.2± 2.25	3.5± 5.50	1.6± 3.68
			% of time ill			
All except skin problems	3.7± 8.3	7.3±18.2	12.0±17.0	8.5±13.82	23.2±19.6	17.2±20.5
Diarrheal	0.0± 0.0	1.7± 9.0	3.0± 7.6	3.1± 8.5	5.9±10.3	7.5±12.9
Respiratory	3.7± 8.3	5.6±17.2	6.3±14.3	4.7± 8.6	11.8±19.7	5.7±12.3

* Sugar water, sugary concoctions, and rice water were excluded

† Morbidity data included only the month during which supplementary food intake was assessed

‡ Mean ± SD

Table 5.71.
Simple regressions of independent variables with infant weight at 6 months expressed as percent of the 50th percentile (NCHS)

Independent variable	n	Regression coefficient	SE	p	R^2
Mother					
Height, cm	77	0.56	0.28	0.05	0.05
Intercept		4.20	43.5		
Weight, 6 mo postpartum, kg	52	0.27	0.15	0.07	0.07
Intercept		74.9	9.6		
Arm circumference, 6 mo postpartum, cm	55	1.04	0.45	0.03	0.09
Intercept		64.6	12.3		
Biceps skinfold thickness, 6 mo postpartum, mm	55	0.48	0.24	0.05	0.07
Intercept		86.3	3.5		
Plant protein intake, 0-6 mo postpartum, g/day	76	0.47	0.17	0.008	0.09
Intercept		70.6	7.6		
Energy intake,0-6 mo postpartum					
Total, kcal/d	76	0.01	0.004	0.002	0.12
Intercept		60.6	9.7		
Fat and CHO, kcal/d	76	0.02	0.005	0.001	0.13
Intercept		59.2	9.7		
Infant					
Birth weight, % of 50th percentile (NCHS)*	74	0.36	0.11	0.002	0.13
Intercept		55.0	11.0		
% time ill with diarrhea	62	-0.77	0.25	0.004	0.13
Intercept		94.0	1.68		
Household					
Socioeconomic status†	83	-2.89	1.29	0.03	0.06
Intercept		98.7	3.81		

* National Center for Health Statistics

† 1=high and 4=low SES groups

N. Multiple Regression Analysis For Predicting Household Sanitation During the 6 Month Postpartum Period

Relationships between household sanitation and certain maternal and household measures were analyzed by simple regression and discussed previously. In this section, the framework of the previous section was used to construct multiple regression models for predicting household sanitation during the 6 month postpartum period. Thus the R-square procedure and CP criterion were used to select possible variable combinations for further testing with multiple regres-

sion analyses. The best single variable for predicting household sanitation was SES. Maternal animal protein and SES was the best two variable combination for predicting household sanitation, followed by SES and maternal plasma ferritin (0-3 months postpartum), with R^2 values of 0.27 and 0.26, respectively (Table 5.72). Possible three-variable combinations, which the R^2 procedure indicated could be important, included SES and maternal animal protein intake during lactation, with any one of four maternal variables: plant protein intake, years of formal education, hemoglobin concentration or plasma ferritin levels, measured in early lactation. Multiple regression analyses showed that among these possible candidates, only maternal plant protein intake and years of education increased the predictive power of the model for household sanitation, when used in conjunction with SES and maternal animal protein intake. No sets of more than three variables proved to be useful in predicting household sanitation.

O. Multiple Regression Models For Infant Weight At 3 and 6 Months

In this section the framework of the multiple regression model for predicting birth weight was used to construct models for predicting infant weight at 3 and 6 months of age. Infant weight was expressed as percentage of the 50th percentile using the NCHS reference. The reference was used primarily to correct for the sex effect on infant weight which allowed for combining the sexes and thereby increased the number of infants used in the analyses. To predict infant weight at 3 months, infant morbidity and maternal food intake data, collected during the first 3 months postpartum were used, whereas for the prediction of 6 month infant weight, data obtained during the entire 6 month period were entered into the analytical model.

The following variables which were examined previously by simple regression analyses were used as candidate predictors:

Characteristics of the Mother

- Age
- Height
- Weight, 3 and 6 months postpartum
- Kcal, plant protein, and animal protein intake during 0-3 and 0-6 months postpartum
- Percentage of time sick with skin ailments
- Percentage of time sick excluding skin ailments

Characteristics of the Household

- SES
- Sanitation-hygiene index
- Infant/child mortality

Characteristics of the Infant

- Weight at birth, % of 50th percentile
- Percentage of time sick with diarrhea
- Percentage of time sick with respiratory illnesses
- Percentage of time sick excluding diarrhea and respiratory illnesses

Supplementary food intake of infant was not included among the variables for predicting infant weight due to missing values for many of the cases. This precluded its use in the PROC RSQUARE.

Table 5.72.
Multiple regression models for predicting household sanitation from certain household and maternal variables

Independent variable	n	Regression coefficient	SE	p	R^2
Model 1					
Socioeconomic status*	90	-0.16	0.04	0.0001	0.27
Maternal animal protein intake, g/day, 0-6 mo postpartum		0.008	0.003	0.009	
Intercept		3.65	0.15		
Model 2					
Socioeconomic status	57	-0.17	0.05	0.0002	0.26
Maternal plasma ferritin status, ug/dl, 0-3 mo postpartum		-0.004	0.002	0.09	
Intercept		3.78	0.16		
Model 3					
Socioeconomic status	90	-0.16	0.04	0.0001	0.28
Maternal animal protein intake, g/day, 0-6 mo postpartum		0.008	0.003	0.0008	
Maternal education, yrs		0.01	0.02	0.06	
Intercept		3.62	0.16		

* 1=high and 4=low SES groups

1. Infant Weight At 3 Months

In constructing the multiple regression model for the prediction of infant weight at 3 months, initially 32 cases and all 15 variables were used, resulting in an R^2 of 0.67. Due to the relatively small number of cases and large number of variables, overfitting was likely. The CP criterion indicated that percent of the 50th percentile weight (NCHS) at birth was the best single predictor (R^2=0.35) of infant weight at 3 months and that maternal plant protein intake during the first 3 months postpartum was the next best single predictor (R^2=0.21). The CP criterion pointed to the best prediction model as one which contained two variables: percent of the 50th percentile weight at birth and maternal plant protein intake (R^2=0.42). When these two variables were used in the model, the number of cases was increased to 56 and R^2 remained the same (Table 5.73). When maternal total kcal intake or kcal intake from fat and carbohydrate was substituted in the model for plant protein intake, the R^2 dropped to 0.33 after each substitution in the model. Simple regressions also demonstrated a higher predictive power of maternal plant protein intake than kcal intake for infant weight at 3 months.

2. Infant Weight At 6 Months

Initially in this analyses, 35 cases and all of the 15 variables described previously were used in the model resulting in an R^2 of 0.52. Again, overfitting was likely. The CP criterion suggested examination of a number of two-, three- and four-variable models with R^2 ranging from 0.41 to 0.49. Maternal plant protein intake was the best single predictor (R^2=0.26) of infant weight at 6 months, and the next best predictor was percent of time the infant was ill with diarrhea (R^2=0.21). These predictors were the best two-variable combination (R^2=0.41) and were included in virtually all reasonable models that included more than two variables. The second best two-variable predictor model for infant weight at 6 months included socioeconomic status instead of diarrhea (R^2=0.33); and the third best predictor included household socioeconomic status and birth weight, expressed as percent of the 50th percentile (NCHS) (R^2=0.33).

When these models were tested using multiple regression analysis, the sample size was increased to 56 and the R^2 value decreased. In the first model that included percent of time the infant was sick with diarrhea and maternal plant protein intake, the R^2 value dropped to 0.22. The addition of socioeconomic status and birth weight, expressed as percent of the 50th percentile, to the model which included percent of time the infant was ill with diarrhea and maternal plant protein intake, increased the R^2 from 0.22 to 0.42 (Table 5.73). When either maternal total kcal intake or kcal intake from non-protein sources was substituted for maternal plant protein intake in the model, an R^2 of 0.40 resulted. Thus the use of either maternal plant protein intake or energy intake for predicting infant weight at 6 months did not change the predictive power of the model. Animal protein intake, however, was not related to infant weight at 6 months in this model. Although simple regression analysis showed significant relationships between maternal anthropometric measures at 6 months postpartum and infant weight, these measures were not significant in multiple regression analysis. This is due, in part, to the significant relationship between maternal anthropometry and birth weight and the presence of birth weight in the model. These results clearly indicated that morbidity of the infant (or the percent of time the infant was ill with diarrhea), birth weight, household socioeconomic status, and maternal food intake, either energy or plant protein, were associated in the expected directions with the weight of the infant at 6 months.

Table 5.73.
Multiple regression models for predicting infant weight expressed as percent of the 50th percentile (NCHS)* at 3 and 6months of age

Independent variable	Regression coefficient	SE	p	R^2
		n=56		
		Weight at 3 months		
Model 1				
Birth weight, % of 50th percentile	0.63	0.13	0.0001	0.43
Maternal plant protein intake, g/d†	0.54	0.13	0.0001	
Intercept	13.3	14.0		
Model 2				
Birth weight, % of 50th percentile	0.60	0.14	0.0001	0.33
Maternal energy intake from fat and CHO, kcal/d†	0.0096	0.0038	0.02	
Intercept	20.9	15.3		
Model 3				
Birth weight, % of 50th percentile	0.60	0.14	0.0001	0.31
Maternal energy intake, total kcal/d†	0.0073	0.0033	0.03	
Intercept	23.2	15.5		

Table 5.73. continued

Independent variable	Regression coefficient	SE	p	R^2
		Weight at 6 months		
Model 1				
Birth weight, % of 50th percentile	0.47	0.12	0.003	0.42
% time sick with diarrhea	-0.59	0.25	0.001	
Socioeconomic status‡	-3.28	1.29	0.004	
Maternal plant protein intake, g/d†	0.39	0.16	0.02	
Intercept	38.6	13.9		
Model 2				
Birth weight, % of 50th percentile	0.44	0.12	0.003	0.40
% time sick with diarrhea	-0.61	0.25	0.002	
Socioeconomic status‡	-3.39	1.31	0.005	
Maternal energy intake from fat and CHO, kcal/d†	0.010	0.005	0.04	
Intercept	40.4	14.4		
Model 3				
Birth weight, % of 50th percentile	0.44	0.12	0.003	0.40
% time sick with diarrhea	-0.59	0.25	0.002	
Socioeconomic status	-3.42	1.31	0.005	
Maternal energy intake, total kcal/d†	0.008	0.004	0.05	
Intercept	41.8	14.4		

* National Center for Health Statistics

† Mean, 0-6 months postpartum

‡ 1=high and 4=low SES groups

P. Other Multiple Regression Models Related to Infant Weight

To study the effect of different variables on infant weight change over the first 6 months, the same sets of independent variables listed in the previous section were regressed with change in weight percentiles from birth to six months of age. In this analysis, the same variables which were significant predictors of weight at 6 months (Table 5.73) were also significant predictors of change in weight percentiles (Table 5.74). The latter analysis explained a higher percentage of variation in the dependent variable (R^2=0.33 to 0.42) than the former analysis. The negative relationship observed between birth weight (% of the 50th percentile) and weight change, shown by multiple regression analysis, was shown previously by simple regression.

A summary of all simple and multiple regression analyses of various independent variables (discussed in this section) with household sanitation, infant morbidity, and infant weight at 6 months is presented in Figure 5.31.

Table 5.74.
Multiple regression models for predicting change in infant weight expressed as percent of the 50th percentile (NCHS)* from birth to 6 months of age

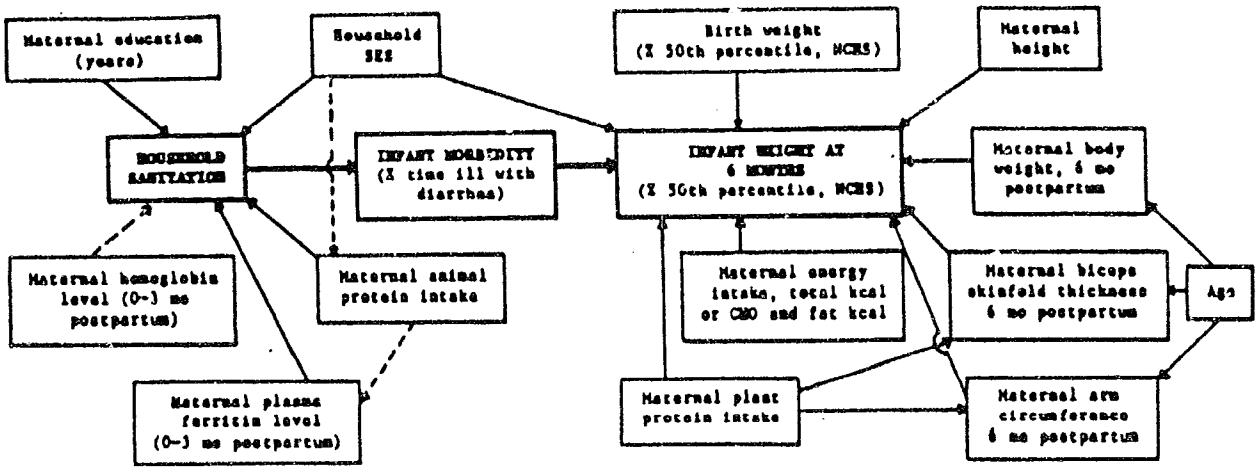
Independent variable	Regression coefficient	SE	p	R^2
	Change in weight percentile, birth to 6 months (n=56)			
Model 1				
Birth weight, % of 50th percentile	-0.53	0.12	0.0001	0.53
% time sick with diarrhea	-0.59	0.24	0.01	
Socioeconomic status†	-3.28	1.29	0.004	
Maternal plant protein intake, g/d‡	0.39	0.16	0.02	
Intercept	38.6	13.9		
Model 2				
Birth weight, % of 50th percentile	-0.56	0.12	0.0001	0.51
% time sick with diarrhea	-0.61	0.25	0.002	
Socioeconomic status†	-3.39	1.31	0.005	
Maternal energy intake from fat and CHO, kcal/d‡	0.010	0.005	0.04	
Intercept	40.4	14.4		
Model 3				
Birth weight, % of 50th percentile	-0.56	0.12	0.0001	0.51
% time sick with diarrhea	-0.59	0.25	0.002	
Socioeconomic status†	-3.42	1.31	0.005	
Maternal energy intake, kcal/d‡	0.008	0.004	0.05	
Intercept	41.8	14.4		

* National Center for Health Statistics

† 1=high and 4=low SES groups

‡ 0-6 months postpartum

(A) SIMPLE REGRESSIONS



(B) MULTIPLE REGRESSION

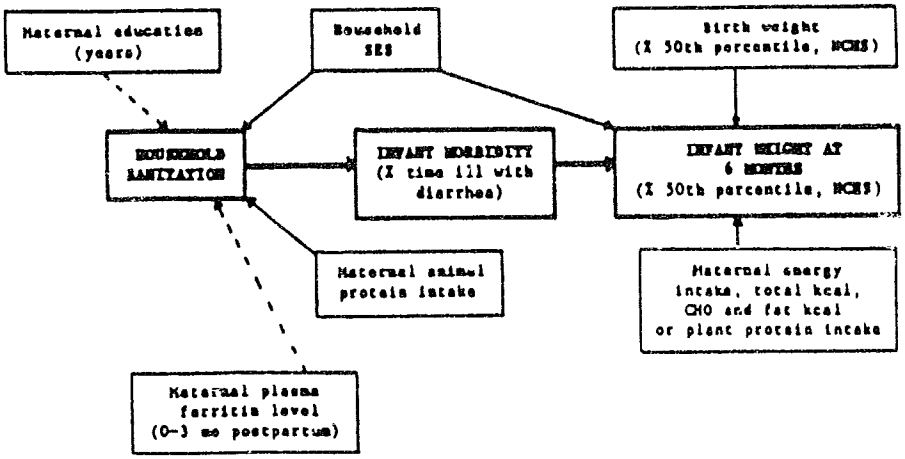


FIG 5.31. Summary of variables related to infant weight at 6 months of age by simple regression (A) and by multiple regression (B) analyses.
——— significant effect; - - - trend ($p<0.01$)

Q. References

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Chapter 6

PROJECT-SPECIFIC RESEARCH

Several pieces of work were undertaken outside the basic variable set in order to address specific methodological problems or to provide data deemed to be important to the interpretation of CRSP analyses.

I. IMMUNOLOGICAL STUDIES

A. Background

The original CRSP design incorporated a variety of measures of immunocompetence. Based on the opinion of members of the External Evaluation Panel that the immunological portion of the design was the least likely to produce major results in relation to the central CRSP hypotheses, the SCB decided part way through the project, under the pressure of funding limitations, to delete the immunologic measures from the basic variables set. The Egypt project found this to be an undesirable decision from the standpoint of institution-building in the host country, since the Nutrition Institute had made the decision to use the CRSP as a catalyst to set up an immunology laboratory and had invested in training several scientist in the relevant techniques. Therefore, we sought other funding in order to retain this portion of the project's design. The University of Arizona's Office of International Programs provided a $10,000 supplement to the CRSP. Analyses of samples already in Arizona were completed, and arrangements were made to transfer the capability for analysis of all samples still in Egypt to the NI. The following paragraphs describe the immunological variables, the completeness of the data, and descriptive results.

B. Measures

Immunologic measures represented cell-mediated, humoral, and secretory immune response and functions. Tests were selected to be minimally invasive, to require small amounts of blood, saliva, or breast milk, and to indicate overall immunocompetence, presence of chronic infection, and contributions to the B- and T-cell systems.

The variables available for analysis include the following:

For cell-mediated immunity:

- Tonsillar size
- Total lymphocyte count
- Percent and number of T-lymphocytes
- Delayed cutaneous hypersensitivity to tuberculin & dermatophytid antigens
- Percent eosinophils

For humoral immunity:

Serum IgA
Serum IgG
C-reactive protein
Serum proteins (transferrin and prealbumin)
C_3

For secretory antibody production:

Salivary IgA
Salivary IgG
Salivary Lysozyme
Breast Milk IgA
Breast Milk IgG
Breast Milk Lysozyme

Not all variables are available on all targets.

Cell mediated and humoral immunity studies were planned for infants when 6 months old, every 6 months on target toddlers and school-aged children, and every year on target adults. Salivary samples were to be collected on the same schedule as the serum samples except that infants were not included. Additionally, pregnant women were to be sampled for serum and saliva in their 5th and 8th months of pregnancy, and saliva samples were to be taken in the 1st, 3rd, and 6th months postpartum. Breast milk samples were taken during the first three days of lactation and in the 1st, 3rd, and 6th months. Tonsillar size was graded once on 6 month old infants and biannually on toddlers and schoolers.

In the field, collection of blood samples met with resistance. Few parents would consent to blood samples from toddlers and it was not possible to obtain any samples from infants. Even in adults, the rate of acceptance of blood sampling declined with time. Breast milk collection was more readily accepted at the beginning than at the end of the project. Collection of saliva samples was more acceptable but not uniformly so.

Table 6.1 shows the availability of samples by target type.

Table 6.1.
Immunologic variables available by target type*

Variable	Lead Males	Lead Females	Schoolers	Toddlers	Infants
Tonsillar Size	125	298	117	173	23
Total Lymphocytes	39	106	21	1	0
T-Lymphocytes	39	107	21	1	0
Eosinophils	81	96	10	1	0
Serum IgA	110	182	29	1	0
Serum IgG	110	182	30	1	0
Serum IgM	110	182	30	1	0
C-Reactive Protein	28	51	4	0	0
Serum Transferrin	110	183	30	1	0
Serum Pre-Albumin	94	154	19	1	0
Serum C-3	109	183	30	1	0
Salivary IgA	86	163	52	11	0
Salivary IgG	46	94	34	7	0

* Total number of measurements. Number of individuals represented is smaller.

C. Collection Procedures

1. Serum

A 10 ml blood sample was collected into a heparinized vacationer tube. Within 1 to 2 hours the sample was transported to the Nutrition Institute laboratory in Cairo. For leucocyte content, 0.1 ml was kept aside; the remainder was centrifuged to separate plasma from cells. The plasma was divided and stored in 4 capped tubes; 0.15 ml was used for the immunological studies. The remainder of the serum was used for non-immunological tests.

2. Breast Milk

Breast milk was collected from the breast that was on the same side of the body as the mother's dominant hand. Immediately after let-down, the mother manually expressed 5 ml of fore-milk from the dominant breast into a capped vial. After the infant finished feeding the mother expressed 5 ml of hind-milk into a second vial. If mixed fore- and hind-milk were required, equal aliquots from both hind- and fore-milk vials were mixed together in a third vial. The vials were stored in a styrofoam ice chest usually with ice, while being transported to the laboratory where 1 ml was removed from each vial for immunological studies. The remaining portions were used for pyridoxine and zinc determinations. All samples were immediately frozen and stored at -30°C until analysis or shipment to the US.

3. Saliva

The subject spat into a sterile tube containing sodium oxide (a bacterial decontaminant). The saliva samples were frozen and stored at -20°C until packed in frozen material and hand-carried to the US.

D. Laboratory Methods

1. Cell-Mediated Immunity (CMI): Tonsillar Size

Tonsillar size was noted by project physicians as a part of each physical examination and was graded on a scale from 0 to 3+. The grading scale was:

0	Trace or no tonsillar tissue seen
1+	Tonsils clearly visible but not extended beyond faucial arch
2+	Tonsils enlarged beyond the arch but not beyond the midpoint between the arch and the uvula
3+	Tonsils extended beyond the midline between the arch and uvula

Tonsillar tissue is normally seen in all children. Most children between 2-6 years of age score 2+ or 3+.

2. Total Lymphocyte Count

A hemocytometer pipette was used to flood the hemocytometer slide with blood. Leishmania stain was used as a differential stain. The number of lymphocytes within one large square was counted. All assays were done in Cairo at the Nutrition Institute's immunology laboratory.

3. Percent and Number of T-Lymphocytes

The procedure described below follows the published procedure of McMurray et al., 1981. Sheep red blood cells (SRBC) were obtained every 3 to 4 weeks from the same sheep at the Cairo University and stored in Alsevers solution. They were washed three times and resuspended at 0.5% in RPMI 1640. Fresh human AB plasma was absorbed with washed SRBC at 4°C in 37°C. Equal volumes (0.25 ml) of the SRBC suspension and lymphocyte suspension were mixed with 0.025 ml of absorbed AB plasma. This mixture was centrifuged at 50 X g for 5 minutes and incubated at 4°C for 24 hours. The pellet was resuspended by rotating or gently rocking the tube. A drop of methylene blue dye

was added to the mixture, which was transferred in a Pasteur pipette, via capillary action, into the hemocytometer counting chamber.

The number of rosettes (lymphocytes attached to 3 or more SRBC) and the number of lymphocytes which did not rosette were counted.

4. Percent Eosinophils

Eosinophils were counted during the differential count of white blood cells. The normal range is 194 ± 56 ul.

5. Skin Tests

Tuberculin and dermatophyte antigens, 0.1 cc each, were injected 5 cm apart on the left forearm. A circle was drawn around the bleb that appeared at each site. This site was then examined for induration and redness 48 or 72 hours later. All assays were done by the CRSP physician staff. Skin tests were not performed on pregnant women or on infants.

6. Immunoglobulins

Single radial immunodiffusion (RID) was used for the precise quantitation of proteins in plasma and other tissue fluids. Behring Diagnostics RID plates which use the endpoint technique of Mancini, Carbonara and Heremans, were used. Mancini, Carbonara and Heremans described a technique in which the antibodies in a gel matrix are present in excess. At endpoint the precipitin ring is in a linear relationship to antigen concentration.

The protein (antigen) solution was applied to a cylindrical well cut in a gel matrix containing a uniform concentration of monospecific antibody. Antigen placed in the well diffuses radially, producing a precipitin ring. Results were quantitated by comparing the diameter of the precipitin ring produced by the sample to the precipitin rings produced by standards of known concentrations. All assays were done at the Nutrition Institute's immunology laboratory.

After the first samples were done, commercial plates[1] were used for all RID assays. For construction of the reference curve, Standard Human Serum[2] was diluted with normal saline to produce three solutions according to the instructions provided on the Standard Human Serum package insert.

IgA was determined using undiluted specimens. In some cases, it was necessary to concentrate the specimens (by ultrafiltration) before application.

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1 LC-PartigenTM IgA RID plates contain a thin layer of agarose incorporating a monospecific antiserum to human H-chain IgA, produced in animals (species indicated on the label). The concentration of the antibody in the gel has been standardized according to the assay range of the plate according to Becker's method

2 Standard Human Serum contains 0.1% sodium azide as a preservative. Any time after the minimum diffusion time (60 to 72 hours) the diameter (d) of the precipitin rings was measured to 0.1 mm accuracy, and calculated^2 (mm^2). The squared diameter (d^2) of the precipitin rings obtained from the Standard Human Serum dilutions (y-axis) was plotted against their respective concentration (x-axis) on linear graph paper. A straight line was drawn (which should intercept the ordinate at 21 ± 4.5 mm^2). Values for the test samples were then determined from this reference curve. Since product specifications assured that the endpoint reference curve was linear, the curve could be extrapolated to the upper and lower limits of the assay range listed on the product label. If the sample concentration exceeded the upper limit of the assay range, the test was repeated with appropriate dilutions of the specimen. If the concentration was below the assay range, the sample was concentrated and reassayed. If the reference curve was not linear or did not intercept the ordinate at 21 + 4.5 mm^2, the procedure was to be repeated; errors in technique of product instability were considered. After reaching the diffusion endpoint (60 to 72 hours) the IgA concentration in the sample was read from the reference curve.

The first wells, dilution 1, 2, and 3, each had 20 ul of Standard Human Serum. Wells 4-12 were each filled with 20 ul of the test samples. The plate was closed tightly, replaced in the container, sealed and allowed to stand at room temperature in a horizontal position. Determinations were made after a minimum diffusion time of 60 to 72 hours.

7. IgG, IgM, C-reactive protein, Transferrin, Prealbumin and C_3

The procedures were the same as for serum IgA except the appropriate antisera-containing plates were used for each protein. IgA, IgG and lysozyme in breast milk and saliva were measured by the same procedures as serum IgA. Average normal ranges are in attachment G.

E. Quality Control

1. Blood

Three types of quality control assays were run on the blood samples. The first involved blood samples from healthy Egyptian personnel that were generally determined to be within the normal range. The second quality control method involved assaying powdered, commercial serum, as quality control for the system and assay techniques in Cairo. Finally, each assay kit had standards of known concentration that were run with the experimental samples.

2. Saliva and Breast Milk

Commercial sources of known concentrations of IgA, IgG and lysozyme were not available for saliva or breast milk. A known serum standard was included with each milk and saliva assay, as were secretory IgA standards isolated from human milk by a commercial source.

F. Loss/Damage to Samples

Initial T-cell levels were much lower than expected. Possibly heat damage had occurred; later samples were placed in a styrofoam box to protect them from damage of temperature extremes.

The first saliva samples were hand carried from Egypt to Texas and then shipped to Tucson. The samples were delivered to the wrong lab where they remained for over 24 hours. When discovered, the samples had thawed. Possibly the bacteria had multiplied at the warmer temperature resulting in some cleavage of the proteins measured. Few bacteria, however, can cleave IgA. The values from these samples will be compared with other samples that were collected later to see if the concentrations were affected.

II. ZINC STATUS

Because zinc deficiency has been previously documented in Egypt, and because of the relationship of zinc deficiency to growth, cognitive performance and other CRSP variables, the Egypt Project felt it relevant to document the range of zinc status in the study community. We studied hair and serum zinc in target toddlers and schoolers. Sampling and laboratory procedures are described below, and Figure 6.1 presents the descriptive results.

A. Sampling Schedule

Originally, it was planned to obtain fingerprick blood samples for serum zinc from target toddlers and schoolers at study entry, 6 months later and at exit. The lack of acceptance of blood sampling resulted in limited availability of data. One hundred forty-three children had at least one serum zinc sample. Only eighteen children (7 schoolers and 11 toddlers) had more than one serum zinc measure. Of the 101 households represented, there were 33 households in which both a toddler and a schooler were sampled.

B. Collection Procedures

Timing of blood sample collection was controlled, since there exist both a post-prandial and a circadian rhythm effect on serum zinc measures. Sampling was done between 10 AM and 3 PM. If the last meal was fewer than two hours previously, sampling was delayed until two hours had passed. In a few cases of toddlers being breast fed on demand, time elapsed from the last feeding to taking of the blood sample was recorded. The site for finger prick was the index or middle finger on the non-dominant hand. A 75 mm acid-washed capillary tube was used for collection. Three tubes per subject were filled, sealed, then placed in a labeled screw-top vial. The samples were transported to the Nutrition Institute in Cairo within four hours, carried on ice in insulated vaccine containers.

C. Laboratory Methodology

Samples were centrifuged in a Clay-Adams Autocrit II Hematocrit Centrifuge; serum from all three capillary tubes was transferred into a single acid-washed cryotube labelled with the subject's ID and date. The capped cryotube was frozen

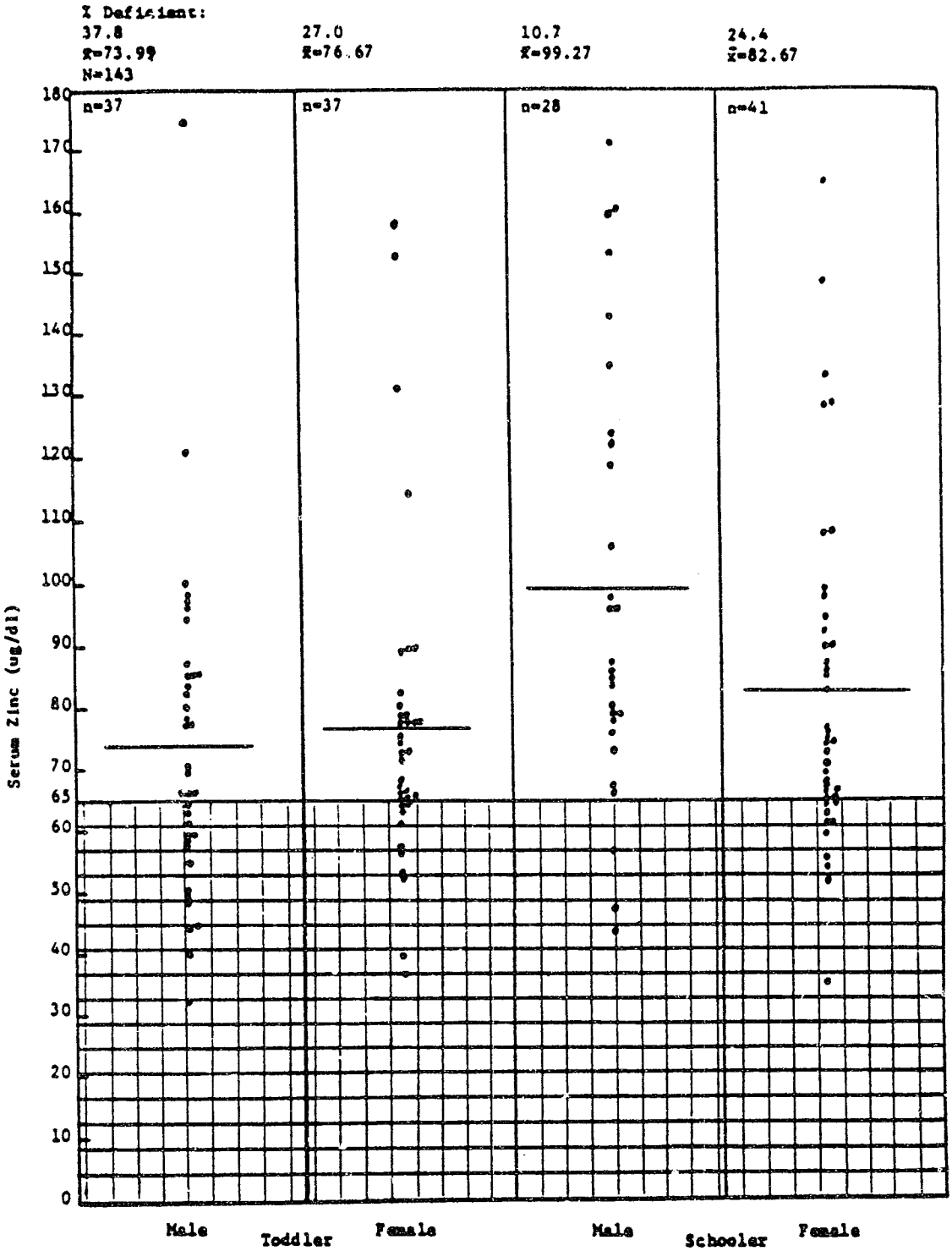

FIG 6.1. Serum zinc measurements of target children in 100 Egyptian households-initial measurements. The criteria for acceptable/deficient values are taken from the Second National Health and Nutrition Examination Survey (Assessment of Zinc Nutritional Status of the US Population Based on Data Collected in the Second National Health and Nutrition Examination Survey, 1976-1980) Food and Drug Administration Cont #FDA 223-2384 (June 1984).

as soon as possible and stored frozen until transferred to the analysis lab at the University of Arizona. Samples were hand-carried by travelers in styrofoam containers packed with dry ice.

At the University of Arizona serum zinc was analyzed by a micro-method that was a modification of a standard method adapted from Smith, Butrimovitz, and Purdy (1979). The modifications consisted of an increase in dilution to 1:19 parts and an increase in total volume to 1 ml [50 ul of serum plus 950 ul of distilled deionized water]. Serum was allowed to reach room temperature before dilution of sample. A control sample of pooled reference serum was similarly prepared in triplicate, as well as two blanks of deionized water. The reference serum, 1 container of which was randomly chosen from 20 containers for each analysis run, was analyzed in triplicate to check intra-sample variability. Reference serum was pooled after collection from several healthy male and female adult volunteers and mixed for a quarter of an hour in 1 ml portions in polyethylene vials at 20°C. Each aliquot chosen for analysis was thawed at room temperature and analyzed, after dilution, for comparison with unknown samples.

The analysis of samples and standards was completed by the flame method on a 180-70 Hitachi Polarized Zeeman Atomic Absorption Spectrometer. The manufacturer's instructions on machine operation were followed for the analysis. Baseline readings of ± 0.001 absorbance were taken before and after each sample and reset as required. The zinc standard was sampled sequentially from most dilute to most concentrated, aspirating each until the reading was stable at "± 0.001 absorbance". Six successive 1 second integration readings were then recorded. After standards were read, the machine was placed in direct reading mode and 5 direct readings per standard were taken. For data analysis the first and last readings were discarded and the middle 3 were averaged. The baseline was stabilized before and after each reading run with distilled deionized water. Calculation of the zinc content in the samples was obtained by least squares comparison to the standard curve.

D. Quality Control

Procedures for collecting, storing and transporting serum for zinc analysis were developed to maximize volume by minimizing loss from the serum microsamples, to eliminate or minimize contamination of the samples, and to prevent dehydration of the microsamples in order to eliminate falsely high values. Glassware was acid-vat washed; plastic and metalware were EDTA-washed.

During Phase I a pilot test was done to assure that collection and transportation could be accomplished without contamination. Serum and plasma samples were taken from each of five individuals and brought from Egypt to the University of Arizona in December 1983 where they were analyzed by atomic absorption spectrophotometry. Both serum and plasma were obtained for comparison purposes. Results showed that reproducibility was within 15 ug/dl.

III. EFFECT OF TEA AND SUGAR ON METABOLIC RATE MEASUREMENT

One of the persistent methodologic dilemmas facing the Egypt project was to explain high proportion of metabolic rate measures which resulted in respiratory quotients over 1.0, and if possible to correct for the factors responsible. Among the hypothesized explanations was the possibility that some subjects had consumed traditional strong, sweet tea on arising and that even though they had refrained from "breakfast" subjects were not measured in a fasted state. This hypothesis was based on the observations of the RMR technician in the field. Accordingly, we undertook a small experiment at the University of Arizona in which four subjects had RMR measured under standardized conditions with prior consumption of strong tea without sugar (control) and with 20 grams of table sugar (treatment).

Subjects were four premenopausal, nonpregnant women between the ages of 25 and 50. Two were of normal weight and two were moderately obese. All were at least seven days prior to or following ovulation based on the date of their last menstrual period and usual length of menstrual cycle. None had chronic or recent illness or recent medications or smoking history. Subjects fasted from 10 pm the previous evening, and reported to the laboratory at 6:40 am. The tea

was taken; the subject lay down and relaxed for 40 minutes. The beginning of measurement was timed so that minute #18 would coincide with 60 minutes after starting to drink the tea.

Open-circuit calorimetry equipment was used, including Amatek O_2 and CO_2 analyzers; an Apple Computer, and face masks identical to the type the project used in Egypt. Measurement of VI, FEO_2 and $FECO_2$ was continued for three 35-minute periods interspersed with 25-minute rest periods. The design was a balanced, cross-over in which the control and treatment conditions were reversed for subjects within each of the normal weight and obese subgroups. Measurements were done two days apart.

Data indicated that there was no substantial effect of the 20 gram sugar load on RQ or RMR. There was a trend toward an elevation in RQ, not clearly localized in hour two or three. With a larger number of subjects a significant effect might be observed, but it is unlikely to be substantial enough to account for the observations in the Egypt dataset.

IV. COMPARATIVE ANALYSIS OF DUBOWITZ SCORE COMPONENTS

Initial analysis of Dubowitz scores on CRSP infants indicated a relatively low mean gestational age (38.0 weeks) in relation to the mean expected. A review of quality-control and training procedures produced no obvious explanation for these results. We obtained through the National Research Center raw data on Dubowitz scoring for a large study of maternal and infant nutrition (Galal and Salem, unpublished) conducted in the early 1980s in Giza, Egypt. Data on 685 infants were available. We entered the data from these infants, along with the 62 Kalama infants who had been born at that time, and conducted a score-by- score comparison.

The mean calculated gestational age of the Giza infants was 38.5 weeks, also lower than expected but higher than that in the CRSP infants. The clinical component of the score did not differ between the two samples (score 26.4 in Giza and 26.0 in Kalama). However, the neurological component was significantly lower in the Kalama infants (24.4 vs 26.5). The total Dubowitz score also was significantly lower in Kalama (50.4 vs 52.9). The correlation of neurological score with birthweight was lower than the correlation of clinical score with birthweight in both groups. Item by item analysis indicated that the major differences between the two groups were in posture, arm and leg recoil, square window, ankle dorsiflexion, and popliteal angle.

Measures which are more affected by muscle tone (head lag and ventral suspension, for example) were not different.

These analyses served to focus our attention on the possibility of neurological deficits in Kalama infants due to nutritional factors, which has been since followed up in work on vitamin B_6 nutriture.

V. FUNCTIONAL CONSEQUENCES OF VITAMIN B-6 INADEQUACY IN EGYPTIAN INFANTS AND MOTHERS

A pilot study conducted in Kalama while Nutrition CRSP was ongoing showed that several lactating mothers had low levels of vitamin B-6 in their milk and a possible link was noted between the low levels of one mother and certain behavioral changes observed in her solely breast fed infant. These findings prompted the present multidisciplinary investigation, supported by the Thrasher Research Fund, of 75 mother-infant dyads in the village to determine possible functional consequences to breastfed infants of maternal vitamin B-6 inadequacy. Of central importance to this investigation was that previous research findings (Morrison and Driskell, 1985; Chang, 1985) showed that the level of vitamin B-6 in human milk was a marker of vitamin B-6 status of both the mother and her solely breastfed infant.

The Brazelton Neonatal Behavior Assessment Scale, a tool used to quantify infant behavior, was administered to Egyptian infants (1-7 days of age) by a psychiatrist trained to criterion reliability. Analyses showed that infants of mothers

with adequate vitamin B-6 status, assessed by vitamin B-6 levels in their milk, were more consolable, had more appropriate rapidity of build-up from quiet to agitated states, and had more optimal control over their response to aversive stimuli than infants whose mothers showed vitamin B-6 inadequacy. When the Brazelton test items were grouped into clusters, maternal vitamin B-6 status correlated positively with control of state of the infant or the amount of stimulation which caused the infant to lose control. These relationships fit the hypothesis of ways in which marginal vitamin B-6 might affect infant behavior.

Marginal vitamin B-6 status was also associated with maternal behavior. Egyptian field workers, who were trained in observational techniques, observed infants and mothers in their homes twice monthly from 3 to 6 months of age. Correlations between maternal vitamin B-6 levels and observational codes aggregated over 3 months of observation indicated that low maternal B-6 levels were associated with higher levels of non-response to infant vocalization, less effective response to infant distress and greater utilization of sib caregivers. Maternal vitamin B-6 levels were unrelated to the level of kilocalorie intake, suggesting that the relationship between vitamin B-6 status and maternal behavior was nutrient specific. The findings of this study are believed to represent the first interdisciplinary examination of relationships between vitamin B-6 status of lactating mothers and certain aspects of their behavior and that of their breastfed infants.

VI. RELATIONSHIP OF VITAMIN B-6 STATUS OF EGYPTIAN MOTHERS TO BIRTH WEIGHT

Prior work (Morrison and Driskell, 1985; Chang, 1985) demonstrated with lactating women that the level of vitamin B-6 in their milk was correlated with that in plasma and could be used as a proxy for their vitamin B-6 nutritional status. In this study the relationship of different levels of vitamin B-6 in milk of 67 Egyptian mothers to birth weight was examined. Mean vitamin B-6 concentration in milk of the Egyptian mothers was 428 nmol/L $\pm$ 11, and was considerably lower than the generally reported levels of 595 nmol/L or higher for unsupplemented women in developed countries. Levels of vitamin B-6 in milk have been reported to closely reflect maternal intake of the vitamin (Kirksey, Roepke and Styslinger, 1981; Styslinger and Kirksey, 1985). Egyptian mothers who delivered low birth weight (LBW) infants had vitamin B-6 concentrations in their milk of only 295 nmol/L $\pm$ 9, which suggested a link between poor pregnancy outcome and maternal vitamin B-6 inadequacy. Low levels of vitamin B-6 observed in the milk (n=23) had a significant positive (R^2=0.22, $p<0.03$) relationship to birth weight (Figure 6.2). This relationship was masked, however, when both low (n=23) and adequate (n=44) levels of vitamin B-6 in milk were regressed with birth weight. The association between maternal vitamin B-6 status and birth weight was supported by the low levels of vitamin B-6 observed in the milk of mothers who delivered LBW infants (<2500 g) compared to values for those who delivered normal birth weight infants and also by the constancy of the low levels over the 6-month period of lactation observed (Figure 6.3). The constancy of the low levels suggested that maternal vitamin B-6 status had not changed. Vitamin B-6 concentration was higher in the milk of mothers who delivered male infants than those who delivered females suggesting that mothers who delivered culturally preferred male infants may have been privy to special foods, higher in vitamin B-6.

VII. LONGITUDINAL CHANGES IN ZINC, CALCIUM AND MAGNESIUM CONCENTRATIONS AND THE EFFECT OF SHORT TERM ORAL ZINC SUPPLEMENTATION ON ZINC LEVELS IN MILK OF EGYPTIAN WOMEN

Effects of stage of lactation on the mineral composition of human milk were examined during the first 6 months of lactation in Egyptian women. Zinc levels, assessed by atomic absorption spectrophotometry, decreased from 1-6 months of lactation; calcium concentrations increased from 1 to 3 months and then decreased at 6 months; magnesium levels increased from 1 to 3 months and then plateaued. The concentrations of these minerals were not significantly different from those of a group of unsupplemented American women, studied simultaneously, with the exception of calcium and magnesium levels which were lower at 6 months of lactation in Egyptian women.

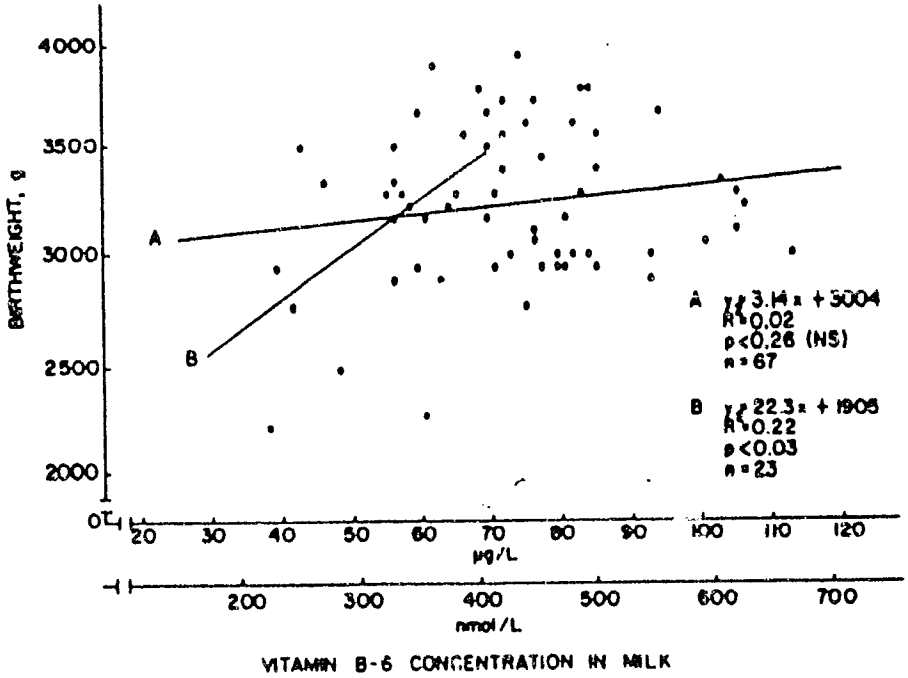

FIG 6.2. Relationship of vitamin B-6 concentration in milk, a proxy for maternal vitamin B-6 status, to birthweight. (Line A is the regression line of birthweight and all levels of vitamin B-6 in milk and line B is limited to low levels, ≤70µg/l milk).

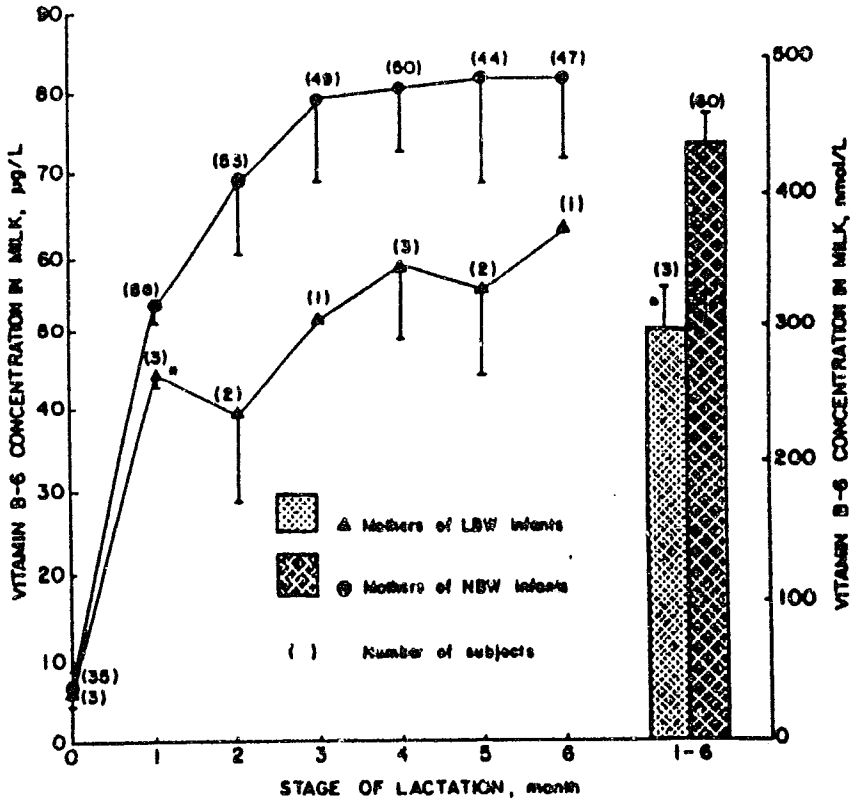

FIG 6.3. Comparison of vitamin B-6 concentration in milk of mothers who delivered low birthweight and normal weight infants. *Significantly different from mothers of normal birthweight infants.

Between 7 and 9 months postpartum, a short term supplementation study of 30 Egyptian women was conducted. A supplement of 50 mg zinc was given to half the women for 34 days; the other women received a placebo. Mean concentration of zinc in the milk was not significantly different for the zinc-supplemented and unsupplemented groups either at the beginning or conclusion of the study period. The findings suggested physiological regulation of the levels of zinc in human milk.

VIII. MATERNAL ZINC STATUS AND PREGNANCY OUTCOME OF RURAL EGYPTIAN WOMEN

The relationship of plasma zinc levels in early and mid-pregnancy, assessed by atomic absorption spectrophotometry, to pregnancy outcome was examined. Mean plasma zinc concentrations of women in the 2nd trimester (0.62 ± 0.18 mean $\pm$ SD) were significantly lower ($p<0.0005$) than those in the 1st trimester (0.81 ± 0.20). These values were comparable to those reported for American counterparts. Among 13 women with plasma zinc concentrations below 0.56 ug/ml, 3 had pregnancy complications including fetal death, haemorrhage, forceps delivery and small for gestational age infant. Among 24 women with plasma zinc concentrations greater than 0.75 ug/ml, 5 had similar complications. Hence, these data showed that women who had high levels of plasma zinc in early and mid-pregnancy were as vulnerable to pregnancy complications as women with low concentrations of plasma zinc.

IX. FATTY ACID COMPOSITION OF MATURE HUMAN MILK OF EGYPTIAN AND AMERICAN WOMEN

Fatty acid composition of mature human milk of rural Egyptian and American women was determined by gas-liquid chromatography. Milk of Egyptian women contained significantly higher percentages of capric, lauric, myristic, linoleic and arachidonic acids, saturated fatty acids (SFA), and polyunsaturated fatty acids (PUFA). The PUFA:SFA ratio in Egyptian samples was 0.54 ± 0.18 compared to 0.47 ± 0.22 in American samples. Increased percentages of medium-chain SFA in Egyptian milk suggested increased mammary gland lipid synthesis. Analysis of Egyptian diets indicated high-carbohydrate and low-fat intakes may have resulted in limited availability and incorporation of dietary fatty acids into milk triglycerides. Thus, increased percentages of medium-chain SFA observed in Egyptian milk may reflect mammary gland synthesis in an attempt to maintain lipid concentrations in milk.

X. PROJECT SPECIFIC PUBLICATIONS AND PRESENTATIONS AT MEETINGS

A. Publications

Borschel MW, Elkin RG, Kirksey A, Story JA, Galal O, Harrison GG, Jerome NW. Fatty acid composition of mature human milk of Egyptian and American women. Am J Clin Nutr 1986;44:330-335.

Karra MV, Kirksey A, Galal O, Bassily NS, Harrison OG, Jerome NW. Comparison of longitudinal changes in zinc, calcium and magnesium concentrations in milk from American and Egyptian women during the first six months of lactation. Am J Clin Nutr (In press).

B. Manuscripts In Preparation

Karra MV, Kirksey A, Galal O, Bassily NS, Harrison GG, Jerome NW. Effect of short-term oral zinc supplementation on the concentration of zinc in milk from American and Egyptian women.

Karra MV, Kirksey A, Galal O, Bassily NS, Harrison GG, Jerome NW. Zinc, calcium and magnesium intakes and growth of American and Egyptian infants during the first six months of age.

C. Published Abstracts and/or Presentations at Meetings

Jerome N, Ricci JA, Aly H, Wahba S, Shaheen F, Abdou Al, Zeinab S, El Feky R, Abou el Gheit Z, Said AK, Galal O, Harrison G, Kirksey A. "Women's food production activities in an Egyptian village undergoing socioeconomic transition." This paper was based on Phase I data and was presented at the 1986 Farming Systems Symposium, Kansas State University, Manhattan, Kansas. Major socioeconomic transformations taking place in Kalama were illustrated with emphasis on changes in male occupation and community subsistence patterns. Cultural sanctions for these changes were described. Data on women's food production activities showed continuity in these traditional gender-based roles. The hypotheses is that maintenance of these roles are linked to maintenance of food habits, food consumption patterns and nutrition.

Jerome N, Sukarry S, Wahba S, Ricci J, Galal O, Harrison G, Kirksey A. "Nutriethnography: A methodologic approach to assess the feasibility of quantifying individual food intake in communal eating contexts with special reference to Egypt." Major aspects of this paper are based on focused ethnographic research on feeding and eating in Kalama from 1982 to 1985. Illustrated with photographs and sketches of the eating process, the paper proposes field strategies for capturing quantitative data on individual food intake in communal eating contexts. Slides made from the photographs have been used in community nutrition/nutritional anthropology class presentations to graduate students.

Karra M, Kirksey A, Galal O, Bassily N, Harrison G, Jerome N. Comparison of longitudinal changes in zinc, calcium and magnesium concentrations in milk of American and Egyptian women during the first six months of lactation. Fed Proc 1987;46(3):897.

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Chapter 7

SUMMARY

I. BACKGROUND

The situation of mild or moderate deficits of food intake is prevalent in most of the world's population, and yet, to date, its functional effects have not been examined systematically. It was against this background that the Nutrition Collaborative Research Support Program (CRSP), a 5-year program (1982-87) sponsored by USAID, was designed to investigate the human functional effects of mild to moderate undernutrition in three countries: Egypt, Kenya and Mexico. The central question addressed by the Nutrition CRSP research was "Under the conditions of mild to moderate undernutrition, what relationships exist cross-culturally between food intake and various human functional outcomes?"

II. AFFILIATED INSTITUTIONS AND COLLABORATIVE ROLES

The University of California, Berkeley, the Management Entity of the Nutrition CRSP, was responsible for the scientific coordination and fiscal administration of the overall project. Five US institutions were involved in the collaborative research effort along with three host country institutions; these included the Universities of Arizona, Kansas and Purdue and the Nutrition Institute in Egypt; the University of Connecticut and the National Institute of Nutrition in Mexico; and the University of California, Los Angeles, with the University of Nairobi in Kenya. Host country field staff were the primary field workers in the project and scientists of the host country were involved fully in the collaborative work. US investigators provided consultation and training of field and other staff when appropriate, and were in the host countries sufficiently often and for long enough periods of time to function in a fully collaborative role.

III. EGYPT PROJECT OBJECTIVES

Data from the National Nutrition Survey of Egypt (1978-80) had shown that chronic undernutrition, i.e. mild and moderate deficits of food intake, was common in Egypt but acute undernutrition was rather rare. Yet, the functional consequences of this situation had not been investigated. Thus, a major objective of the Egypt Project was to investigate prospectively in a rural Egyptian setting the effects of mild to moderate variation in energy intake on human functional performance, measured in terms of frequency, duration and severity of morbidity, pregnancy outcome, cognitive development, and sanitation practices. Other objectives of the project were to develop and validate techniques and instruments for field research in human nutrition and to assist the host country in institution-building and in the development of infrastructure to improve nutrition services.

IV. EGYPT PROJECT HYPOTHESES

This report of the Egypt Project has focused on data which were related to two of the research hypotheses:

A) Food intake of the toddler (18 to 30 months of age) affects his/her anthropometry, morbidity, and psychological development.
B) Maternal food intake during pregnancy and lactation influences the infant's endowment at birth and during the first 6 months of breast feeding. Also, maternal intake affects maternal activities for sanitation, which in turn influence infant morbidity.

V. OVERALL PLAN OF THE STUDY

The Egypt project was carried out in three phases. Phase I, which began in August 1982 and lasted through September 1983, was devoted to the tasks of selecting a study community, negotiating with local officials and with village leaders for conducting the study in the community, completing a village census, assembling and training a field team, and testing the feasibility of various data collection methods. Phase II, which began in November 1983 and ended in December 1985, was the period of collection of the basic data set. Phase III was a data analysis phase; these activities came to an official end with the end of the contract on September 30, 1987. However, neither time nor financial resources were adequate to fully exploit the information in the database; major portions of it remain unanalyzed, and even those portions which have received concentrated attention for this report hold much yet-untapped information.

VI. THE SITE

The village Kalama was selected as the project site by a team of investigators from Egypt and the U.S. after it was determined that this community met the established criteria for a field site. Kalama is located in the Kaliobia governorate approximately 25 kilometers north of downtown Cairo. When the project was initiated in 1982, Kalama's 8,544 residents (1,470 households) represented 0.4% of the population of Kaliobia (1,913,000 people). The village has been undergoing rapid socioeconomic transformations. Occupational diversity is at the heart of these changes. Primary factors facilitating these transformations are the proximity to Cairo, close contact to the outside world through transportation, travel and the communications media, availability of jobs for skilled and unskilled labor in and close to Cairo, and the severe lack of housing in Cairo which effectively extends Cairo's suburban area to include Kalama.

Agriculture is the basis of economic life in Kalama. This does not, however, exclude other economic activities which are diverse, but small in scale. Fifty-six percent of the households are engaged in non-agricultural occupations, 21% hold agricultural occupations and 23% are involved in both agricultural and non-agricultural occupations. Kalamans play a major role in the larger economy through the marketing of their varied farm products which are cultivated using flood irrigation. A small irrigation canal feeds all the farms.

The social dynamics of change and stability are reflected in village social structure as measured by socioeconomic status (SES). Combined demographic and village-specific economic factors (household and farm assets) were used to develop SES scales. Four SES levels were identified in the study sample. A large majority (44%) qualified for the lower intermediate SES category, followed by 26% for the low SES category, and 15% for each of the other two categories: high SES and upper intermediate SES categories. In terms of social dynamics, the large lower intermediate SES group is positioned to move up or down the scale, depending upon social and economic conditions.

Most Kalamans are young; the mean age was 18.8 years in 1982, with 56.2% of the population under 21 years of age. Household size varied widely, with a mean of approximately 6 to 7 individuals per household. The nuclear family, consisting of a married couple and their unmarried offspring, was the dominant family type in two-thirds of Kalama

households. Division of labor was strict, particularly in domestic work. However, women and men work together in the field and in family commercial ventures. The community's school system includes an Islamic religious educational program as well as secular schools at the primary, preparatory and secondary levels.

VII. RECRUITMENT AND DESIGN FOR DATA COLLECTION

The census of the village accomplished during Phase I formed the basis for identification of potential target households for the study. Prior to the census, the village was mapped, divided into 12 blocks, and households were then numbered by block and by individual household. Recruitment was spread geographically over the entire village. Since Phase I data showed that socioeconomic variability was reflected in geographic terms, this process also provided the necessary variation in socioeconomic status. A census update was undertaken at the beginning of Phase II, and completed between November 1983 and February 1984; this provided a list of potentially eligible households for Phase II research. Eligible households included one or more of the following target individuals:

A) A woman either in the first trimester of pregnancy or likely to become pregnant and whose infant would be 6 months of age before the end of the study;
B) a child who would be 18 months of age during the first year of the study; and/or
C) a child between 7 and 9 years of age during the first year of the study.

Once the household was selected, parents of the target child also became key subjects for the study. Recruitment of households was designed to yield at least 100 of each target type for whom data could be collected over a 12-month period.

Actual eligibility of households was ascertained by the sociodemographic field team after paying a visit to each potentially eligible household. Eligible households were enrolled in the study if they agreed to participate after receiving a careful explanation of the study, including what it would entail for them. This procedure was adequate to recruit families of target toddlers and schoolers, but did not identify adequate numbers of target pregnancies. Additional target pregnancies were recruited from a pool of women at high risk for pregnancy, identified from the most recent census data as either a) newlyweds who did not yet have children, or b) mothers whose youngest child was more than one year of age. These women were visited monthly to ascertain their menstrual status; if uncertain, they were offered a pregnancy test. From these results, a list of women in the early stages of pregnancy was generated, and households were recruited.

A total of 312 Kalai households were enrolled; 258 completed the study. The attrition rate was 17.3% (54 households). Target individuals completing the study included 153 toddlers, 121 schoolers, and 124 infants. A total of 191 pregnant women were followed (131 recruited as described above and 60 mothers of toddlers or schoolers who became pregnant during the study); the discrepancy with number of infants is because not all mothers elected to continue the study after the delivery of the infant. A cyclic pattern of data collection was devised to ensure a routine schedule of visits to each household and to reduce intrusion into the households. Most measurements were repeated monthly or over 3-month intervals. Stable measures (e.g. adult height) were repeated less frequently, and unpredictable measures (e.g. morbidity) were repeated weekly. The measurement schedule for 400 potential targets was designed for completion within the 2-year projected study period.

VIII. TODDLER GROWTH, MORBIDITY AND FOOD INTAKE

Target toddlers were found to be relatively short for age, but were appropriate in weight-for-length. Change in weight and length over the year between 18 and 30 months showed considerable variation within the group - as much as a tenfold difference in the slope of the regression of weight on age. On the average, toddlers showed slight increases in both length and weight by 30 months of age relative to the NCHS standards. The average velocity of growth in length was

greater for girls than for boys, but sex-related differences were not observed in body weight changes. There was a clear effect of season on growth, with maximum increase in weight occurring in the winter months and minimum growth during May-July, coinciding with the seasonal peak incidence of diarrhea. Household size was related to growth; children from larger households showed better growth gains than those from smaller households. The details of household composition relationship to growth need to be further investigated. Since the largest households were also extended family structures, the relative advantage may have to do with more adults or more women available to care for the child.

Kalama toddlers experienced an average of almost 10 illness episodes per year. Percent of time ill averaged 11 percent, but ranged as high as 30 percent. Approximately 40 percent of the illness episodes were gastrointestinal in nature, and another one-third were respiratory infections. Both diarrhea and respiratory illness showed distinct seasonal patterns, with diarrhea peaking in April-July and respiratory illnesses in December-February.

Several problems were encountered in the estimation of food energy intake. A significant number of toddlers were partially breast fed in the early part of the study since weaning generally occurred between 18 and 24 months of age. Breast milk intake was not quantitatively measured; therefore, food intake data for partially breast fed children were incomplete. Various attempts to model and correct for breast milk intake proved unsatisfactory; therefore breast feeding status was used as a variable in the analytical models to account for this variability.

A further difficulty arose due to the rather late discovery of some apparent errors in the project's food composition database. These are currently being corrected. However, in the meantime analytical models were re-run using conversion factors for energy from the carbohydrate, fat, and protein content of each food item. The use of this approach has no doubt introduced some error into the food intake variable which should be decreased when the revised energy values become available. The analyses which include food intake in this report, therefore, must be regarded as tentative.

Analytical models predicting morbidity variables showed no independent effect of food intake in the previous month. There was a close relationship of anthropometric status to the severity of gastrointestinal illness but not of respiratory illness. Analysis including lagged models indicated that once initial status, sex, breast feeding status and time of year were accounted for, no significant independent effect of food intake on weight or length could be detected. Models incorporating morbidity and food intake indicated that percent of time ill with diarrhea was a much stronger predictor of weight than food intake. It is necessary to keep in mind that time ill with diarrhea may also affect food intake. Since food intake data were collected only two days per month, such an effect could easily be missed even though analysis showed no greater incidence of missing food intake data when the day of data collection coincided with an illness day.

Previous analyses using the project's food composition database to calculate energy value of food showed small but significant and positive effects of food intake on weight. Whether these earlier analyses were in error or whether the interim decision to use energy values calculated from Atwater factors has simply obscured the relationship is unknown at this time. Thus we emphasize the preliminary nature of these results.

IX. TODDLER COGNITION AND BEHAVIOR

In terms of the overall question raised by the CRSP, the findings of nutrition and psychology indicated a low but consistent relation between food intake and cognition and behavior in Egyptian toddlers. However, the overall pattern of results indicated that it is a major oversimplification to interpret the present findings just in terms of a nutrition-development relation. Specifically, the following complexities must be considered:

A) Nutritional intake covaries with measures of the stimulation potential of the toddler's environment. Environment in turn shows a more consistent relation to toddler cognitive and behavioral development than does nutrition. Hence, any discussion about nutrition and development in the toddler period must be framed in terms of the role of the toddler's environment as a mediator of observed relations.

B) Data from the project indicated that the toddler's nutritional intake may be, at least in part, governed by the toddler's prior behavior patterns. The implication of this pattern of results suggests that focusing on food intake in isolation, without consideration of relevant toddler characteristics that may influence food intake, may lead to potentially misleading conclusions about the role of food intake on development.

C) Potential developmental risk factors like lowered food intake, increased morbidity or inadequate psychosocial environments did not appear to equally influence all aspects of toddler behavior and development. Thus, statements about the relation of intake to behavior or development must be qualified by the specific aspects of development or behavior that are being studied. Depending upon the outcome parameter chosen, lowered food intake may show either a detrimental influence or be unrelated to outcome.

Overall implications of the pattern of results involve the necessity to view inadequate food intake as part of a complex of risk factors, that needs to be studied utilizing conceptually based, longitudinal systems models.

X. PREGNANCY AND LACTATION OUTCOME

The study group of 104 pregnant women was characterized as young (20 to 30 yrs), of high parity (4 to 7), largely (90%) illiterate, and most (66%) from households classified as low or low intermediate socioeconomic status. The women were generally short in stature and normal to overweight for height in early pregnancy.

Among all of the variables examined in this study for their relationship to birth weight, maternal anthropometry showed the most significant influence. Body weight or derivations of it, i.e. body mass index or % ideal weight for height and also upper arm circumference and tricep skinfold thickness measurements, whether made in early or late pregnancy, were significant predictors of birth weight. Mean weight gain during the 2nd and 3rd trimesters of pregnancy was 7.4 kg. Weight gain during the 2nd and 3rd trimesters in combination with early pregnancy weight was a significant predictor of birth weight, explaining about 30% of the variation in birth weight. Maternal age, parity and height were significantly correlated with body weight in early pregnancy and were, therefore, indirectly significant predictors of birth weight.

Over a period of 90 days or more of observation, episodes of maternal illnesses were only about two per person during pregnancy and one and one-half per person during lactation; each episode had a mean duration of 6 days. Respiratory and diarrheal illnesses comprised the largest percentage of time ill in both pregnancy and lactation. Maternal morbidity variables were not significantly related to birth weight. However, another approach would be an examination the converse of this, i.e. the impact of repeated pregnancies and extended lactation on maternal health and nutritional status. This is a research question which has been proposed for future investigation using the database of the three-country projects.

Maternal energy and protein intake during the course of pregnancy were not significantly related to maternal weight or birth weight. Nevertheless, some of the effect of food intake would obviously be through body weight prior to pregnancy and which clearly affected birth weight. Young mothers of low body weight delivered infants of lower birth weight and faced a greater risk of delivering low birth weight infants (<2500 g) than older mothers of higher body weight. This risk was even greater when weight gains during pregnancy were minimal. These findings indicated that young underweight mothers should be particularly targeted for nutritional support. Furthermore, this support would appear to be most beneficial when given prior to pregnancy, since early pregnancy weight was one of the strongest predictors of birth weight in this study.

Birth weights of Kalama infants showed an almost normal distribution according to the National Center for Health Statistics (NCHS) reference. However, the low incidence (5.5%) of low birth weights (<2500 g) in this population is misleading since some mothers refused to participate in the study after their pregnancy outcome was unfavorable. Growth faltering in both weight and length of infants became evident by 3 months of age and increased progressively to 6 months of age when data collection for the infants was completed. Also, the strikingly low values for upper arm

circumference and skinfolds at 6 months of age suggested that some infants had not accumulated normal fat stores. Most infants decreased significantly in weight expressed as percent of the reference median during the first 6 months; at birth, one-half of the infants were at or above the reference median compared to one-fifth at 6 months of age. This shift was evident even among infants who were in the highest weight percentiles at birth. Infants in the lowest weight percentiles at birth either remained at approximately the same percentile or showed only small gains by 6 months of age. Household SES was significantly higher for infants who exceeded the 50th percentile of weight at 6 months than for those who fell below this percentile.

Maternal energy intake (total kcal/day or kcal from carbohydrate and fat) and plant protein intake (proxy for energy intake) during lactation significantly influenced infant weight at 6 months. During the 6 month period of lactation per se, little change in maternal body weight was noted. However, both biceps and triceps skinfold thicknesses increased significantly from delivery to 6 months postpartum, suggesting some increase in body fat. This was supported by a mean gain of 2 kg in body weight from early pregnancy to 6 months postpartum. These findings were more likely in older mothers than younger ones. The significant effects of maternal height, weight, and arm circumference on infant weight at 6 months were possibly indirect effects of these variables on birth weight.

The mean number of illness episodes observed per infant over an average of 150 days was approximately 6, with a mean duration of 6 days per episode, i.e. infants were ill approximately one-fourth of the time observed. Gastro-intestinal illness comprised 37.9% and respiratory 31.8% of all illness of infants. Diarrheal illness (26% of all illnesses) was the largest single contributor to infant morbidity. Respiratory illness of infants followed a seasonal trend and was highest from December to March whereas diarrheal illness was age-related and was higher from 3 to 6 months of age than from birth to 3 months. The diarrhea variable was the best single predictor of infant weight at 6 months.

Household sanitation index was correlated negatively and significantly with the percent of time infants were ill with diarrhea which in turn significantly affected infant weight at 6 months. Household sanitation was influenced significantly by household SES and by several maternal variables, including years of education, animal protein intake and plasma ferritin levels. Also, there was a tendency for maternal hemoglobin levels to be correlated with household sanitation. These effects were presumably mediated by maternal iron status and its influence on work performance.

Sugar water, sugary concoctions, and rice water, which were widely used as infant supplements, were excluded from the analyses of the effects of supplementary foods on different infant variables. Excluding these supplements, infants who received other supplements during the period from birth to 3 months of age weighed significantly less than unsupplemented infants. After 3 months of age, other variables influenced infant weight more than supplementation.

Mortality was high among the 161 live born infants; 10 deaths occurred, 5 within 1 to 2 days following delivery. Information about the cause of death was usually sketchy due to unwillingness of family members to discuss events which preceded the death. Household SES was significantly lower for the families of infants who died compared to that of families of the infants who survived.

The findings of this study indicated clearly that birth weight, household SES, maternal food intake, either total energy or plant protein, and morbidity of infants (percent of time ill with diarrhea) were associated in the expected directions with infant weight at 6 months. In order to increase the probability that infants will be of normal birth weight and that they will survive and attain optimal growth and well-being, maternal and child health programs should focus on ways to meet the energy needs of women prior to and during the course of pregnancy and lactation and explore ways to improve household socioeconomic status and sanitation.

XI. THE DATABASE AND FUTURE RESEARCH PLANS

The database available from the Egypt Project, Nutrition CRSP is rich and complex. While well documented, it is not yet completely ready for final multivariate analyses and thus some of the conclusions which are drawn at this time are

subject to future qualification. This is particularly true of the food intake variable because of the still ongoing revisions in the food composition database. Future efforts will focus first of all in this area, since the use of these data depend heavily on the quality of these variables.

Pending support and adequate resources to do so, plans are to intensively analyze the data in at least two areas which have shown great promise in preliminary analyses. In both cases, three-country project proposals have been submitted by CRSP investigators on behalf of the entire group. The first is in the area of reproduction, with a focus on maternal health; the second is an attempt to develop functional anthropometric classifications based on subsequent morbidity, growth performance, and cognitive measures.