TABLE 4.2.2 C

The Percent Prevalence of S. haematobium by Source and Use of Water Supply in the Sample from Beni Suef.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	10.5	9.7	15.4	9.7	NC
Piped outside	21.4	21.0	19.1	19.3	NC
Hand pump inside	27.7	30.0	30.9	27.2	NC
Hand pump outside	30.6	31.0	29.0	28.5	NC
Canal	35.3	35.2	31.7	31.3	32.3

*No Cases

The initial approach was to determine if there was a relationship between the percentage of homes with piped inside water supplies and piped outside supply and the prevalence of infection by region. The hypothesis was that differences in the coverage of piped in and/or piped outside supplies in the respective communities would not result in significant differences in the distribution of prevalence of any of the parasites studied. The hypothesis was not rejected. Table 4.2.2 D shows the results. Kafr El Sheikh, which had the highest coverage and usage of protected water supply did not have the lowest overall prevalence of infection for any parasite. The lowest prevalence was found in Aswan did.

For protozoan infections, the case of Kafr El Sheikh with the overall lowest prevalence suggests that the hypothesis should be rejected. However, Aswan had better

overall water supply coverage than Beni Suef, but the prevalence of any protozoan was higher in Aswan (49.3%). This inconsistency supports the hypothesis. Furthermore, the distribution of the helminth infections further supports the hypothesis that water supply and infection between regions were unrelated.

TABLE 4.2.2 D

Regional Comparisons of Water Supply and Parasitic Infection

Variable	Percentage of Characteristic by Region		
	Kafr El Sheikh	Beni Suef	Aswan
Pipe inside	4.1	1.1	2.0
Pipe outside	90.6	30.3	47.3
Any parasite	51.3	52.1	119.7
Any protozoan	43.3	48.0	49.3
Any helminth	14.4	9.4	11.1

This hypothesis was explored within regions to see if at the community level, greater coverage of protected water supply was related to infection distribution. Table 4.2.2 E was prepared to show this pattern at the village level.

The percentage of water supplied inside the home was highest (11.6%) at study site number 16. Piped outside supply was also high (87.4%). Parasite infection would correspondingly have been lower than at other sites where coverage was not as good. Study site number 19 has distinctly lower coverage of both types of supply and the

TABLE 4.2.2 E

Study Site Comparisons of Water Supply and Parasitic Infection

Region	Study Site Number	% Piped Inside	% Piped Outside	%+ Any Parasite	%+ Any Protozoan	%+ Any Worm
Aswan	1	0.0	0.0	28.4	26.3	4.6
	2	3.6	74.1	56.3	52.2	8.9
	3	4.1	77.9	52.8	49.6	9.8
	4	2.4	84.3	48.1	45.2	6.7
	10	0.0	0.0	46.4	41.7	10.4
Beni Suef	11	0.0	0.0	45.8	43.0	6.5
	12	3.2	81.8	52.0	47.5	11.5
	13	1.0	5.2	45.3	42.5	6.1
	14	0.0	50.8	54.0	50.0	9.1
	15	1.5	13.7	32.3	26.3	7.1
Kafr El Sheikh	16	11.6	82.4	57.8	55.3	8.5
	17	5.6	94.9	42.2	36.2	12.1
	18	2.1	96.3	41.0	28.2	19.5
	19	1.0	79.2	35.6	29.7	9.9
	20	0.5	95.3	49.3	95.5	12.2

lowest prevalence for any parasite infection (35.6%). Prevalence of any protozoan infection was also lower. The study site with the overall lowest prevalence for all three composite parasite variables was number 1 in Aswan. In order to reject this hypothesis, coverage of protected water supply should be very high. In fact this study site was the lowest for protected water supply in the entire study. This village did not have any piped sources of water, nor were there any tube well sources as in study sites 10 and 11. Attempts to find inverse correlations between the dependent

and independent variables by multiregression were not successful either. There was a significant positive correlation (R=.51) between helminth infection and outside water supply, i.e., the greater the use of outside piped water supply by a village, the higher the prevalence of helminth infections in that village. This finding rather strongly suggests that the hypothesis, at this level of study, cannot be rejected. However, it is very important to note that this correlation does not indicate that the hypothesis is accepted - only that it is not rejected.

The multiple regression analysis did reveal an association not previously observed. There was a positive correlation (R=0.25), although weak, between the amount of inside and outside piped water supply. It seems reasonable that in villages where piped supply to the inside of homes was more common, outside supply coverage would also be more frequently found.

All tests for association failed to support a rejection of this hypothesis when the data were on a country-wide individual basis. That is, all individuals were classified according to the type of water supply used for their home and cross-classified in respect to infection. None of the composite infection variables were observed to occur more frequently when the water supply in question was not present, except for canal sources. Table 4.2.2 F shows typical results for the relationship between different water supplies and infection by any parasite.

TABLE 4.2.2 F Relationship Between Different Water Supplies and Infection by Any Protozoan

Type of Water Supply	Percent Positive for any Protozoan Infection		
	Water Supply Present	Water Supply Not Present	Significance
Piped Inside	44.3	36.2	P<.005
Piped Outside	38.0	35.5	P<.009
Canal Supply	30.8	37.0	P<.000
Hand Pump Supply			
Inside	37.8	36.3	NS
Outside	34.8	36.8	NS

Note the significant association with canal supply. Prevalence of any protozoan infection was lower when the canal supply was used.

This analysis was finally carried to the level of examining differences between individuals within villages. In this analysis, tests of significance (chi square) were performed for each of the three composite infection variables for five different types of water supply by each of the 15 study sites. Two hundred twenty-five individual tests were made and reviewed. Using this approach, confounding related to village specific factors was controlled for. There were three study sites, all located in Kafr El Sheikh, which showed a significant association in the direction favoring rejection of the hypothesis. All were for piped water outside of the home; none of the piped inside supplies showed an appropriate relationship. Two

cases were for infection with any helminth and one for infection with any protozoan. The following table shows these results.

TABLE 4.2.2 G

Study Site# Infection	% Prevalence Piped Outside Supply		
	Present	Not Present	Significance
16 Any Helminth	7.0	13.6	P=.0184
18 Any Protozoan	22.2	35.7	P=.0424
20 Any Helminth	13.6	31.8	P=.0008

The evidence shown in Table 4.2.2 G is not sufficient to reject the hypothesis, especially since the overwhelming body of the results did not support it. The possibility is remote that additional evidence supporting rejection can be found. The general lack of association at different levels of the study as well as the findings of associations in the wrong direction indicate that this study should recommend the acceptance of the hypothesis that water supply and parasite infection are not related.

There are most likely many reasons for failing to find a relationship that would be expected, given our knowledge of the parasites studied and their documented modes of transmission. One example would be the insensitivity of the variables under study. As stated previously, infection - not disease - was measured. However, this investigator

suggests that this study is profoundly confounded by the uniform presences of the zir. The potential for the zir to adversely affect the microbial quality of any water supply is suspected to be great. Certainly, all future studies must consider in their study design methods for measuring the impact of the zir in transmitting infection.

Personal hygiene habits and sanitation in food handling join with the use of the zir to make three broad items on which information is almost totally lacking for the rural Egyptian population. Local behavior patterns will no doubt make for complexity in any study design aimed at these three subjects.

4.2.3 Excreta Disposal and Infection

Table 4.2.3 A shows the results of the first step in the analysis to test the overall hypothesis that there is not a significant decrease in parasitic infection when a latrine is present in the home. The approach is the same as used in the analysis of water supply and infection. Higher coverage of latrines had no relation to lower overall infection, nor to a lower prevalence of protozoans or helminths.

TABLE 4.2.3 A

Region	Percent Latrines Used	Any Parasite	Any Protozoan	Any Helminth
Kafr El Sheikh	88.0	51.3	43.3	14.4
Beni Suef	43.1	52.1	48.0	9.4
Aswan	77.4	49.7	49.3	11.1

No regression correlation was found between the percentage of used latrines in a study site and the corresponding prevalence of the three composite infection variables. Table 4.2.3 B is a presentation of latrine coverage and infection prevalence by study site. A strong negative correlation would be necessary, in which prevalence decreased with increasing latrine coverage, before considering rejection of the hypothesis.

On a country-wide basis the prevalence was significantly higher for all infection except E. coli.

Actually, the prevalence of E. coli was lowest for those who had latrines but did not use them. This was true also for infection by any parasite, any protozoan and E. histolytica. Table 4.2.3 C shows the results, which might suggest that the design and/or use of latrines in the study population was such that transmission of infection was promoted rather than prevented. This is not a conclusion here, however.

TABLE 4.2.3 B

Study Site	% Latrines Present Used	Percent Prevalence		
		Any Parasite	Any Protozoan	Any Helminth
1	54.7	28.4	26.3	4.6
2	93.9	56.3	52.2	8.9
3	89.2	52.8	49.6	9.8
4	87.0	48.1	45.2	6.7
10	49.5	46.4	41.7	10.4
11	35.8	45.8	43.0	6.5
12	34.4	52.0	47.5	11.5
13	22.4	45.3	42.5	6.1
14	37.2	54.0	50.0	9.1
15	94.4	32.3	26.3	7.1
16	98.0	57.8	55.3	8.5
17	92.7	42.2	36.2	12.1
18	80.1	41.0	28.2	19.5
19	74.7	35.6	29.7	9.9
20	92.2	49.3	95.5	12.2

The relationship between individuals within regions was examined and the significant differences noted in Table 4.2.3 D. None of the six parasitic infections examined for in Kafr El Sheikh were associated with the presence of a

TABLE 4.2.3 C

Parasite	Percent Prevalence Latrine			P Value
	Used	Not Used	No	
Any Parasite	42.6	34.3	40.8	.014
Any Protozoan	37.5	28.6	36.9	.0167
Any Helminth	10.0	10.2	8.3	.0418
G. lamblia	7.9	6.0	5.3	.0005
E. histolytica	5.6	1.5	4.6	.0105
E. coli	39.9	30.5	43.0	.0009

latrine which was used.

TABLE 4.2.3 D

Significant Association Between Latrine and Infection by Region

Infection	P Value		
	Kafr El Sheikh	Beni Suef	Aswan
Any Parasite	N.S.	N.S.	.0006
Any Protozoan	N.S.	.026	.0001
Any Helminth	N.S.	N.S.	.0400
G. lamblia	N.S.	N.S.	N.S.
E. histolytica	N.S.	N.S.	.0153
E. coli	N.S.	.0021	.0230

The significant associations observed for infection by any protozoan and *E. coli* in Beni Suef had a lower prevalence, in both cases, for the presence of a latrine that was not used. In Aswan, all significant associations were in the wrong direction, i.e., prevalence of the

respective infection was higher for those with latrines which were used.

Tests for associations within villages on an individual basis did not reveal evidence that would suggest rejecting the hypothesis. Like the analysis for water, a great number of chi square tests were examined. Typically, infection was evenly distributed across the latrine categories. Collectively, the results on latrines and infection are insufficient to suggest that the hypothesis be rejected.

The assumption that latrines have a potential negative impact, by promoting transmission, considering their design and poor maintenance, cannot be made either.

4.2.4 Housing Variables and Infection

The hypothesis that there was no association between the following housing characteristics and infection variables was not rejected at any level. The variables listed below, were tested for association with infection and found to be unrelated:

1) Construction material
2) Floor material
3) Roof condition
4) Stable location and cleaning frequency
5) Persons per room
6) Attachment

Crowding, or increasing the number of persons per room, was not found to be associated with infection Nor was any association seen when houses were grouped into: few rooms-few people, few rooms-many people, many rooms-few people, and many rooms-many people. One would expect that infection might be lower in the many rooms-few people category as

compared to the few rooms-many people one. However, the reverse was observed, although it was not statistically significant.

When dung as a cooking fuel was classified against all other types of fuel or combinations of fuel, dung was found to be associated with infection by any protozoan ($P<0.0021$). The relative risk, however, was small (1.11) as was the odds ratio (1.19).

The date of construction of a house was found to be associated with infection by any parasite and more strongly, with infection by any protozoan. Specifically, a significant and unique trend was seen. As the age of the house based on the date of construction increased, prevalence of these two infections also increased. People living in older homes, in this study, had more infection than those that lived in newer ones - even though the newer homes are apparently more crowded (see Section 3.1.4). This relationship is explored more fully in the following section, 5.1.

4.2.5 Environmental Variables and Height and Weight Measures

The same analytic approach was used to assess the hypothesis that one or none of the environmental variables was related to the height and weight measurements (actually the hypothesis to reject was: the height-weight variables were not associated with the environmental variables in question). Each of the following environmental variables were tested against mean Z scores for height for age, weight

for age, and weight for height (ages from less than one year to 15 were used):

1) Piped in water supply
2) Piped outside water supply
3) Hand pump water supply
4) Canal water supply
5) Latrine
6) Building construction
7) Floor construction
8) Roof condition
9) Stable location and cleaning frequency
10) Cooking fuel
11) Persons per room
12) Attachment
13) Date of house construction

The mean Z score of the locale under study served, in this analysis, as an internal reference population to which comparisons were made.

The significant associations observed between the height-weight and the environmental variables were typically inconsistent. For example, mean Z scores for weight for height were appropriately greater for children in homes with piped in water supply and for children in homes which obtained water from outside piped sources. However, when the water supply was drawn from a canal, the mean Z score was equivalent to that for piped in water. Note also that significant values were high, but absolute differences were less than a half of a Z score (one-half of a standard deviation). This lack of absolute differences in value was also a typical feature. Table 4.2.5 A illustrates this example.

There was no consistent and significant evidence to reject the hypothesis. None of the environmental variables

TABLE 4.2.5 A

Z Scores for Weight for Height:
Country-wide

Status	Z Scores		
	Piped Inside	Piped Outside	Canal
Not Present	-0.005	-0.105	-0.038
Present	0.395	0.070	0.353
P Value	0.000	0.000	0.000

tested were found to be associated in a fashion to suggest that height-weight variables would be good predictors of hazardous rural environmental conditions. Analysis at regional levels of observation did not contribute to new insights or potentially useful relationships. At more specific levels (village or individual) the numbers of respondents were too few for meaningful testing as the population strata was restricted to ages less than one, to fifteen.

CHAPTER FIVE

INTERACTION OF DEPENDENT AND INDEPENDENT VARIABLES

Introduction

In this chapter the results of analysis of more than one independent variable and the dependent variables are reported. The approach was to determine if there were relationships between selected independent variables and the dependent ones that were suppressed because of third variable confounding. Alternatively, this analysis sought to amplify associations observed between a dependent and an associated independent variable. The most notable association detected and discussed in this section is the date of construction of houses and infection.

5.1 House Construction Dates and Infection

The mean date of construction for all the houses examined throughout all study sites (2396 homes in all) was 1942. Therefore, the average house in the sample was 34 years old. The overall prevalence of infection with any species of parasite studied was 51%. At the country-wide level of analysis there were no *a priori* reasons that the average age of the houses in the study would explain, even in part, the level of parasitic endemicity observed.

On a regional basis, the mean age of houses was greatest in Aswan. Beni Suef was in between and Kafr El Sheikh had, on the average, the most recently built homes. These differences were statistically significant ($P < 0.0001$). Table 5.1.1 A shows that infection with any

species of protozoan inversely followed this pattern of house ages. The prevalence of any protozoan species among the three study areas was highly significant ($P < 0.0001$) as well. This was primarily due to the larger numbers of specimens examined in the study rather than large differences in prevalence among the regions. The prevalence of any species of parasite or of any helminth, although significantly different among regions, did not have the same distributional pattern.

A least squares method of linear regression was used to measure the association between house dates and these infection variables. The regression coefficient was high ($r^2=0.80$) for the prevalence of infection by any protozoan against mean house dates. The slope coefficient was negative (-0.26), indicating an inverse relationship between the two variables, i.e., newer homes had lower prevalences. However, the hypothesis that the slope of the line fitted is significantly different from zero could not be rejected ($p= 0.2965$). These results are also shown in Table 5.1.1 A.

The next level of organization examined revealed a significant difference in the relationship between house dates and infection prevalence with any protozoan. The mean house dates of construction were determined for each study site (15 in all) and compared with the respective prevalence of infection with any protozoan. For both variables there were significant differences in variation among the study sites. An analysis of variance for house dates was

TABLE 5.1.1 A

Analysis of Dates of House Construction
By Region and Prevalence
of Parasitic Infection

Region	Mean Date of Construction	# of Houses	% Prevalence		
			Any parasitic infection	Any protozoan infection	Any helminth infection
Kafr El Sheikh	1950	209	51.3	43.3	14.4
Beni Suef	1942	258	52.1	48.0	9.4
Aswan	1928	690	49.7	49.3	11.1
Regression Analysis	Constant		47.586	57.33	6.65
	Slope		0.09	-0.26	0.12
	r^2		0.58	0.80	0.28
	Significance(P)	-	0.4504	0.2965	0.6456

significant (P<0.000) as was a chi square test for the differences in prevalences (P<0.000) between study sites. The large numbers sampled tend to contribute to significant findings rather than large differences in the variables. Figure 5.1.1 A graphically shows this comparison. Although r^2 was half of the previous analysis (r^2 + 0.4) the level of significance was substantial (P=0.013) as was the slope (-4.97). In this case, there was an advantage of going from a general level, regions or areas, to a more specific one at the individual study sites. The observation of an association between house dates and infection by any protozoan was reinforced and provides a basis either for the further developed etiologic relationships or for revealing

confounding factors unique to the areas studied.

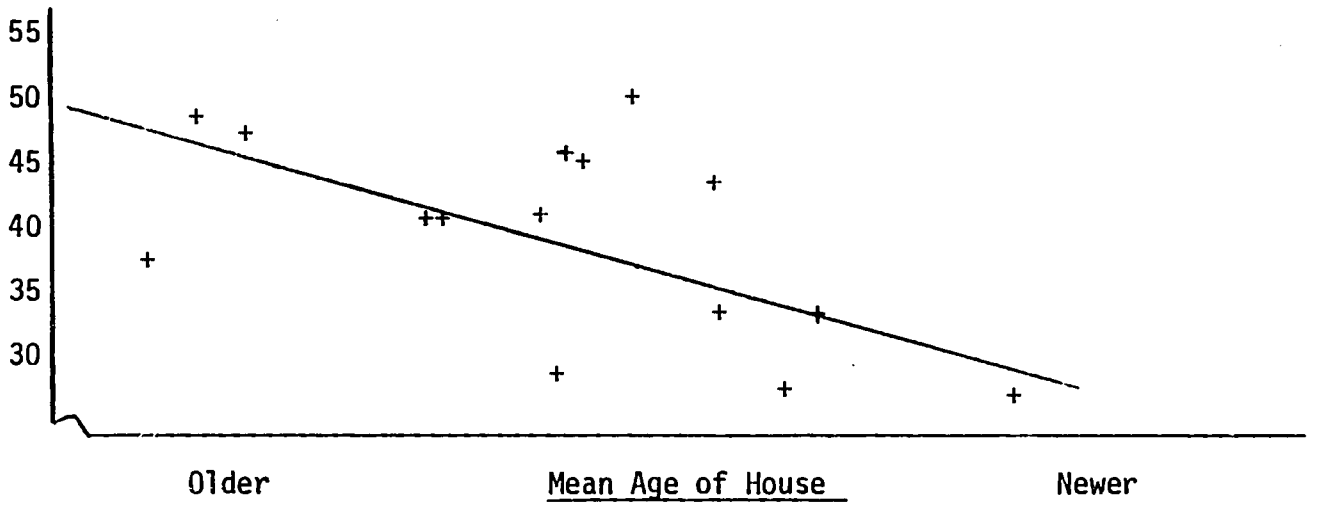
The next logical step was to examine this association at the individual level. The infection status of each individual and the date of home that the individual lived in was compared. First house dates were aggregated into 10 year age groups. Then individuals were assigned to the appropriate groups according to the date of the house that they lived in. Each of these groups was further classified by the presence or absence of infection. Table 5.1.1 B below shows the number in each group and the percent positive by house dates. The entire study population was included in this analysis.

The chi square test was very significant for any parasitic and any protozoan infection, $P< 0.000$. This means that there were statistically significant differences between the levels of prevalence for these two groups. This was not the case for infection with the helminths. A trend of decreasing prevalence in the newer houses can be seen for the first two categories, any parasite and any protozoan. Figure 5.1.1 B and Figure 5.1.1 C show the graphic relationship between any parasite, any protozoan, and house dates respectively. A least square regression showed that the slopes of the fitted curves for both dependent variables were significant ($P<0.000$), although both curves had negative slopes - again indicating that older homes were more frequently infected with protozoans, and the slopes were shallow (a coefficient of less than 0.1). Also, the

Figure 5.1.1 A

Rates of Protozoan Infections Plotted Against

Mean Age of Houses for all Study Sites



+ = one study site

TABLE 5.1.1 B

Relationship Between House Dates and Infection

Infection	Date of Construction							
	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1976
Number of individuals	1152	1123	1130	978	1339	1657	2076	928
% Positive with any parasite	46.6	42.6	45.2	42.2	42.3	37.6	40.2	36.9
% Positive with any protozoan	41.9	38.6	39.9	38.7	36.8	32.8	34.6	32.7
% Positive with any helminth	10.2	8.4	10.1	8.0	11.2	8.5	9.4	9.3

correlation coefficients were small ($r^2 < 0.1$).

This weak, although rather consistent, association observed between the age of a house and protozoan infection is further examined below. An attempt is made to identify other related factors, possibly environmental, that will explain this relationship in terms that are understood about the transmission of these parasites.

An analysis of housing conditions was made where house dates and other housing factors were compared on a house to house level of analysis. The question asked was whether there are associations between certain housing characteristics and the house age. There is an assumption made that specific characteristics of the house would not be

Figure 5.1.1 B Parasitic Infection Prevalence (%) by Date of House Construction (year)

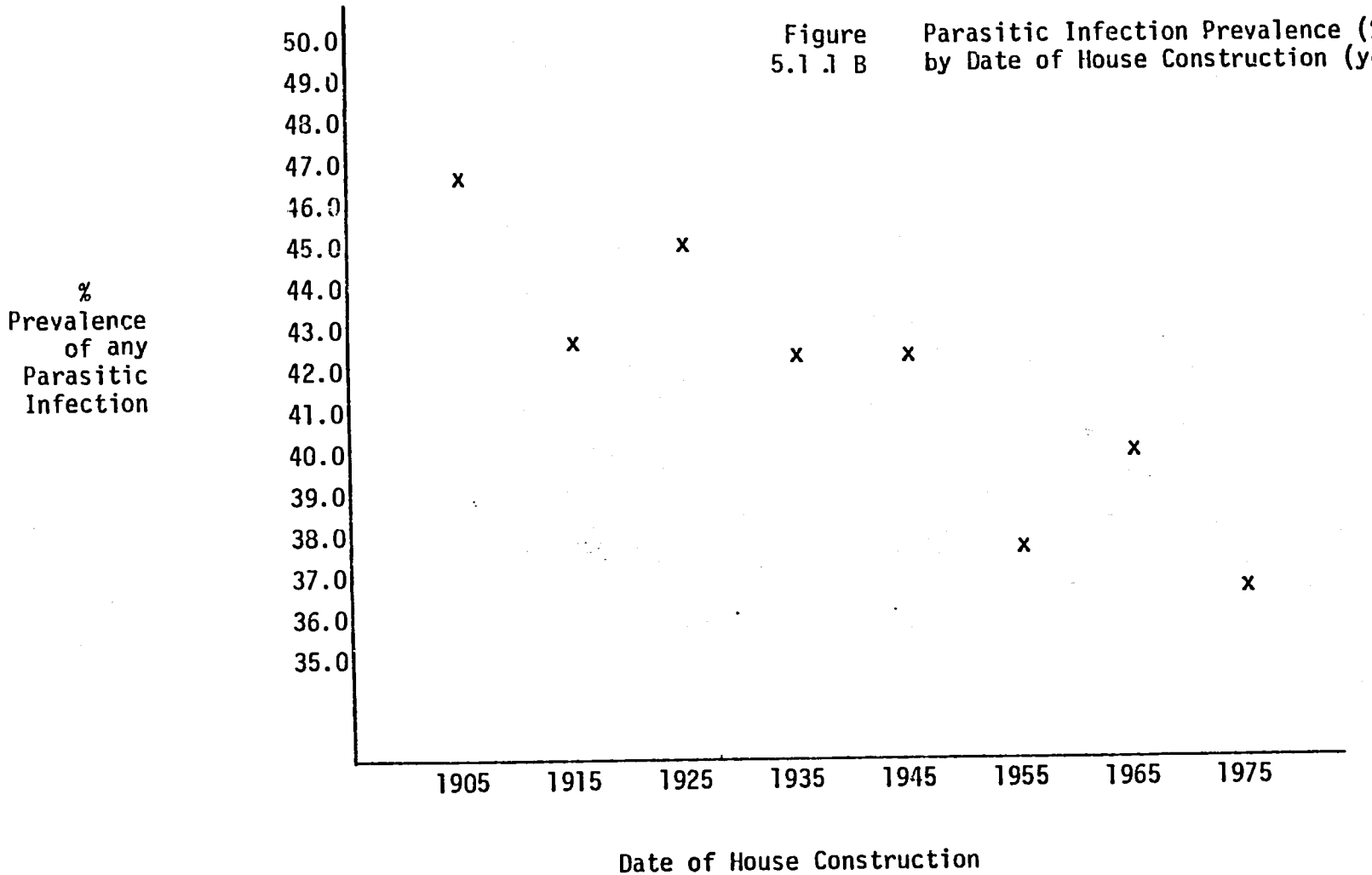
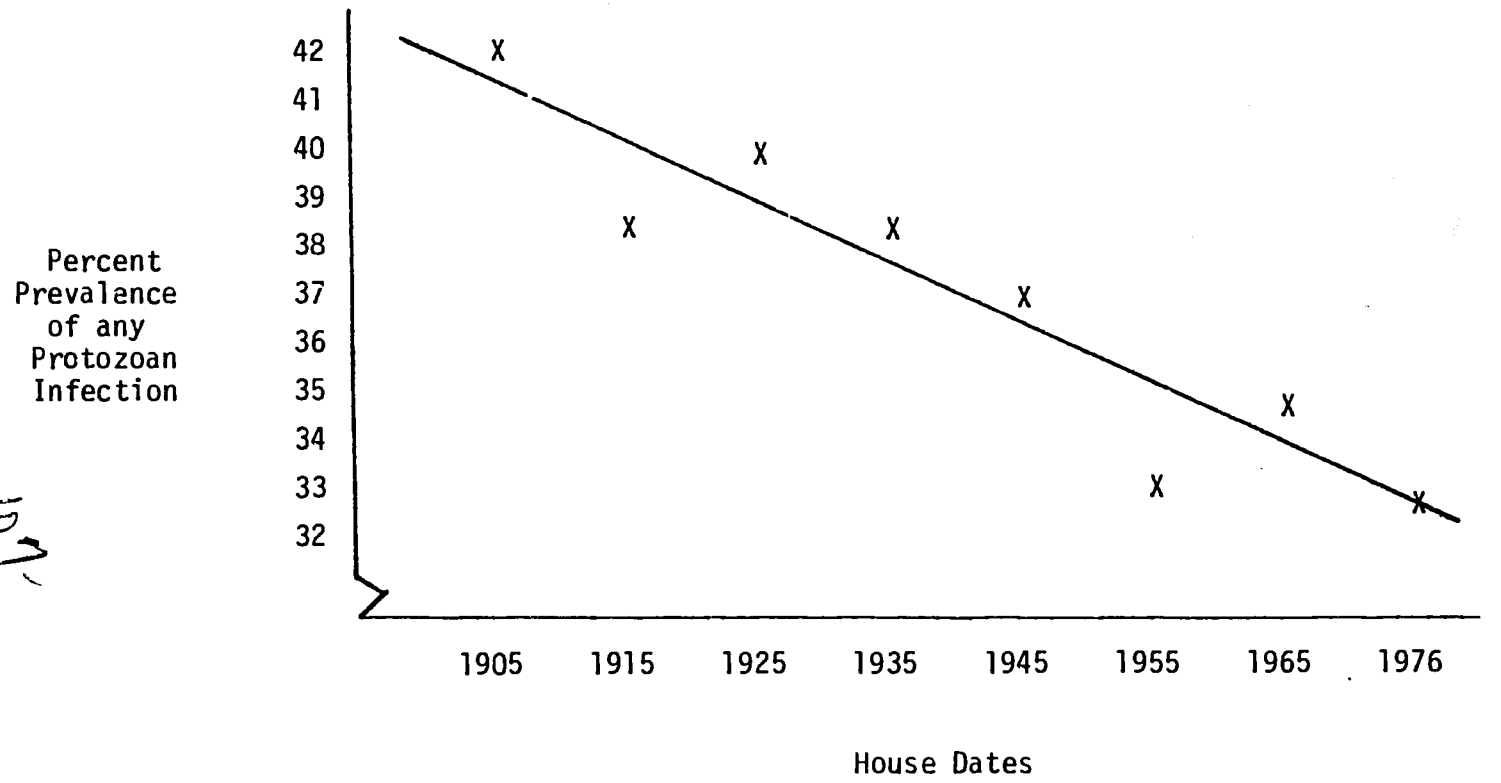


Figure 5.1.1 C Relationship Between Infection with any Protozoan Parasite and the Date of House Construction



changed from the time of construction. For building material - mud, brick, etc. - this assumption is relatively safe. For other factors, excluding latrines, what was in place at the time when the study was completed is assumed to have been present at the time of construction.

From the previous chapter on housing it was shown that there was a trend for newer homes to be made of brick. Therefore, the prevalence of protozoans was compared between brick, mud, and M/B homes at different levels of house age. Each home was classified into eight ten-year age groups by date and cross-classified by brick,mud or M/B construction. The percent prevalence of any protozoan infection was determined for brick, mud and M/B at each age.

Significant differences were not found for brick or M/B homes. Although both roughly followed the previous trend, the numbers in the positive categories were substantially reduced. Mud homes, house dates and any protozoan infection were very significant ($P<0.000$) and the trend was quite evident (tests for trends were not made). It should be borne in mind that the prevalence of any protozoan infection for mud homes was the lowest of the three construction classifications tested (Mud=36.0%, brick=37.9% and M/B= 39.0%).

Other housing variables were also found to enhance this relationship. The presences and use of latrine, concrete floors, indoor stable and gas as a cooking fuel were cross-classified by infection and house dates. Concrete floors,

in particular, showed a good trend ranging from 45.8% in the oldest homes to 29.0% in the newest ones. Significant differences were lost when mud homes without latrines were examined. Mud homes with latrines which were used was significant ($P<0.000$) and demonstrated a district trend (44.0% to 24.8%).

Each of the above housing variables was associated with the independent variable, house dates. Separately, they were not good predictors of infection. Placed in a context of time, the findings suggest that the above housing characteristics play a role in the transmission of common protozoan infections.

This same classification approach was used to examine the effect of dung in the house. Although brick and mud homes were not significantly associated with infection by any parasites, regardless of the specific species, the presence of dung as the only cooking fuel was related to protozoic infections ($P<0.0021$). Dung use was not found to be distributed across different house ages as a trend, however. Therefore the analysis of dung use, infection by any protozoan, and house age using the same approach as previously stated, did not provide additional insight to the correlation between house age and infection.

The relationship of house date and any protozoan infection was examined by study site and separately by age. Two study sites did not provide sufficient information on house dates to be included. The two were both in the Aswan

region, numbers one (Kakhor, Aswan) and ten (Bimban, Kom Ombo). In other sites the reduction in numbers resulted in greater variation and loss of significance. Only three individual study sites were found to be significantly associated and all three were from the Nile Delta region. The loss of significance due to a reduction in numbers was indicated by the very significant results obtained from a regional level analysis. When the comparisons were made within regions both Aswan and Beni Suef showed very significant associations, P=.0007 and P=.0068 respectively.

When the analysis was stratified by age, the distribution of infection by any protozoan was roughly equal between house dates for the first age and second age groups. As already noted, age groups had a significantly lower prevalence than the general population. This suggested that age was a correlate of both infection and house dates. A regression of age against house dates (country-wide level) was found to be significant. Younger mean family ages were found in houses with more recent dates of construction indicating the presences of younger children. Not surprisingly, older homes were found to house older persons who in turn were associated with a higher prevalence of infection.

Therefore, the relationship of house construction dates and infection was most severely affected by age, a classical confounding variable.

5.2. Family Structure and Dependent-Independent Variable

Associations

In order that confounding factors that might affect transmission of the parasites between members of the same family are identified, an analysis of infection among the study families was designed and carried out. For this analysis, a series of new variables was created which represented the characteristics of each family considering the family unit as a population. For example, if three members of a four-member family were infected with a parasite, the respective variable would take on a value of 0.75. This new variable represented the prevalence of infection within the family unit for the given parasite.

The primary question was, "If one member of a family has an infection, are other members of the same family at an increased risk of infection?" Infection was found to be evenly distributed regardless of family size in terms of children or the age structure of the children in the family. Furthermore, the hypothesis that the number of persons infected in families of equal sizes, was evenly distributed, was not rejected. The hypothesis was tested only for families of three to seven members and from zero to three members infected with any protozoan. Comparisons were not made between families of different sizes. There was an equal number of families not significantly different with one, two or three members infected. More variation was noted for smaller sized families. Table 5.2.1 A shows the results for family sizes five to seven for infection in one

to three members.

TABLE 5.2.1 A

Infection Between Family Members

Family Size	Number of Families	Percentage With		
		One Member Infected	Two Members Infected	Three Members Infected
5	427	24.7	27.0	15.9
6	348	24.3	23.8	23.3
7	242	15.3	25.5	21.9

These results suggest that infection with any protozoan is not dependent on infection of another family member. This suggests that the family members may be exposed to as much infection outside the home as inside. However, this study was not cross-sectional in design and therefore did not measure the rate of secondary case acquisition. The measurement of secondary case rates is a more refined, accurate and acceptable determination of infection transmission in the home, in the community, and between the community and the home.

Given these results, it was not expected that the mean prevalence of infection in the children would be significantly higher when the mother was also infected. A student test of the mean prevalence of infection with any protozoan was found to be 40.0% in families with infected mothers and 30.0% in families with non-infected mothers ($P<0.000$). The implication is that children whose mother

was infected were at greater risk of becoming infected. However, the results do not indicate a direction of transmission - only an association, i.e., the infected mothers may have acquired the disease because they were members of families with a greater proportion of the children in the family infected.

All major housing and environmental variables were tested for associations (ANOVA) with the prevalence of infection variables in the family. The hypothesis was that prevalence was associated with the presence or absence of one or more of the environmental variables listed in the previous sections 4.2.2 - 4.2.4. No consistent and significant associations were found. As in previous results, prevalence of infection in the family was found for selected independent variables significantly associated. This is contrary to accepted theories of transmission of the parasite in question. These results, at the family level, established that no factors were included in the collection of the data from the field - and therefore, in the data set for familie - that would confound the analysis at other levels of organization.

5.3 Relationships Between Latrines, Water Supply, Housing and Sex.

Anecdotal information obtained during field visits implied that latrines were built to provide privacy, especially for adult females. Therefore, analyses of latrine association with infection should be restricted to

those who potentially used them, i.e., females. The hypothesis that there was no difference in the prevalence of infection between females who used latrines, had latrines and did not use them and did not have latrines was not rejected (country-wide level data), P=0.22.

Most homes that had piped in water supply had latrines, 93.6% compared to homes that did not have piped inside supply, 73.7%. As already shown, infection was unrelated to piped inside supply or latrines. In the presences of both piped inside supply and latrine use, the absolute frequency of infection was elevated. The prevalence of infection in individuals whose homes had both latrines (used) and piped inside supply was 45.6% and in those without either, 36.4% were positive. Piped outside supply, latrines and infection by any protozoan followed the same pattern with much smaller, insignificant differences, 37.8% compared to 36.9%. Drinking water supply from the canal and latrines (used) had an absolute prevalence that was less than the comparison group which included those that did not get water from the canal for drinking and did not have a latrine. The difference was, however, insignificant. In the group with latrines who did not use the canals for a water supply the absolute prevalence was highest. Table 5.3 A summarizes these results.

5.4 Infection and Pregnancy

The data collected in the field included the number of pregnancies, the number of live births, and the number of

TABLE 5.3 A

Percent Infected With Any Protozoan

Water Supply	Latrine	
	Used	None
Piped Inside		
No	37.2	36.4
Yes	45.6	33.3
Piped Outside		
No	36.6	36.9
Yes	37.8	35.6
Canal		
No	38.0	36.7
Yes	32.8	25.0

stillbirths, that each participating married female could recall. All three variables were tested individually against infection by all three composite infection variables. The hypothesis that the number of pregnancies, live births and stillbirths were evenly distributed between infected and uninfected was not rejected. As many infected women were pregnant, for example, five times, as non-infected women. Proportionally, the same held true for the number of live births and the number of stillbirths. Figures 5.4 A and B graphically show this relationship for the number of pregnancies and stillbirths for infection by any protozoan.

Figure 5.4 A

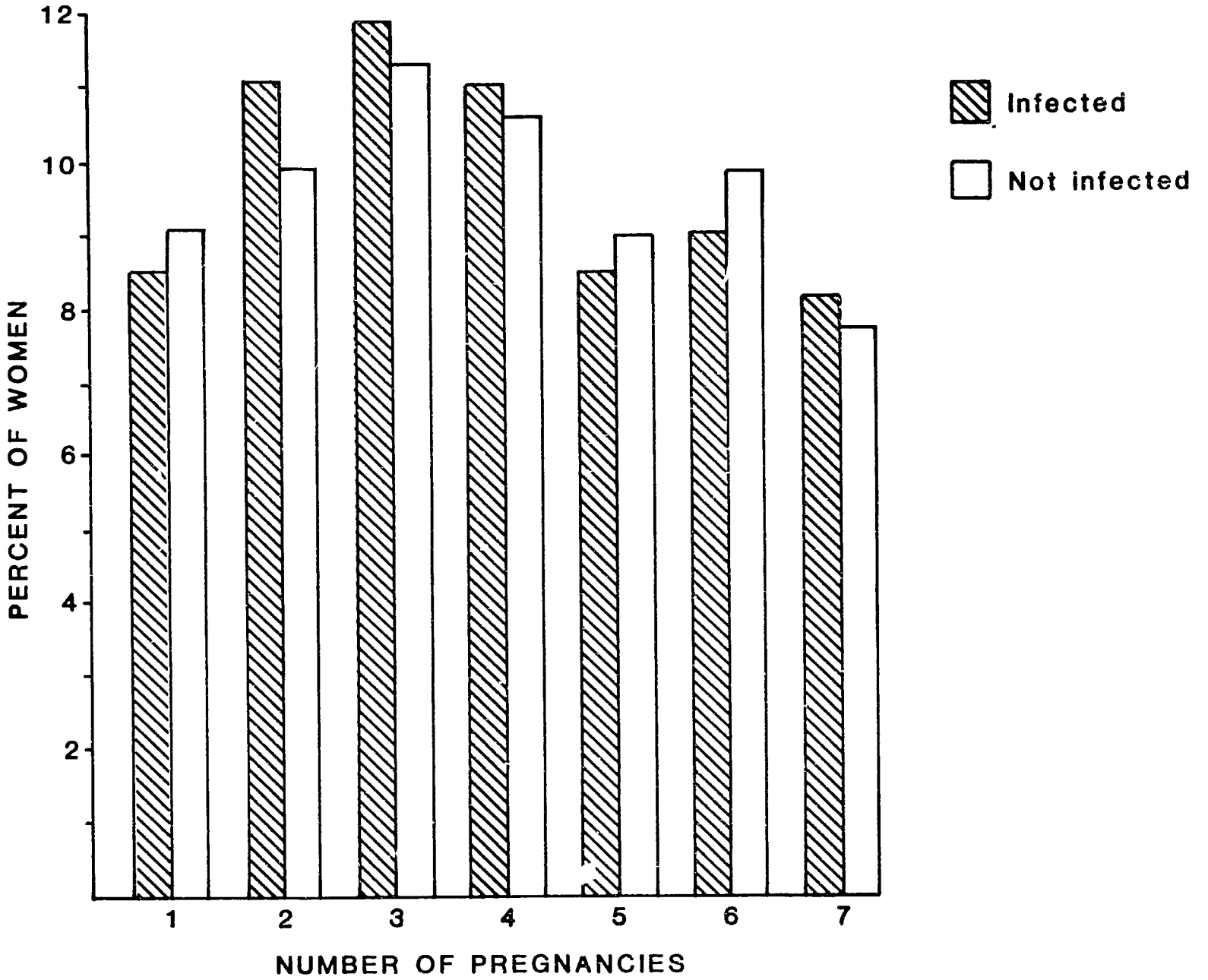
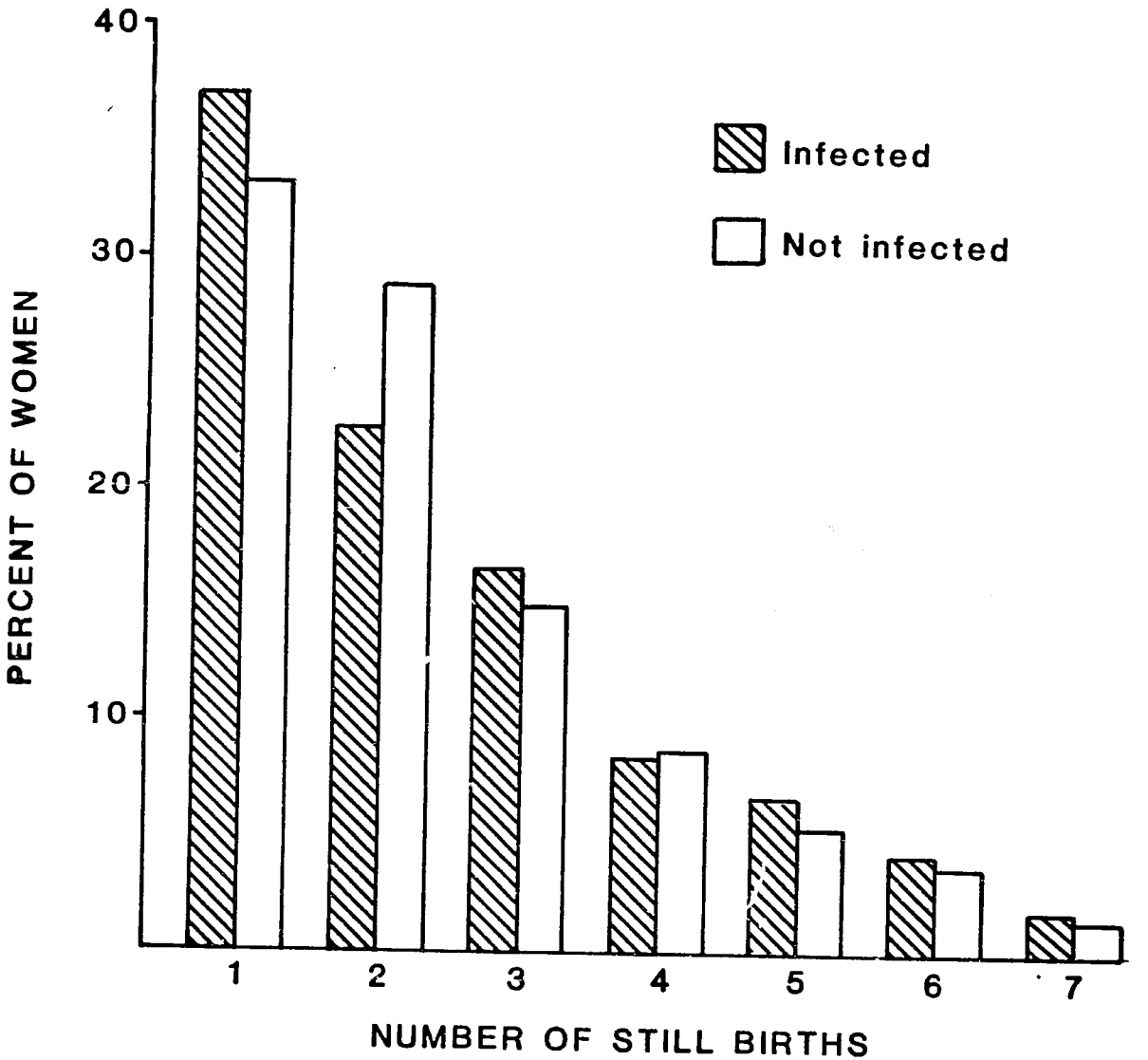

12
10
8
6
4
2
PERCENT OF WOMEN
1
2
3
4
5
6
7
NUMBER OF PREGNANCIES
Infected
Not infected

Figure 5.4 B


40
30
20
10
PERCENT OF WOMEN
Infected
Not infected
1
2
3
4
5
6
7
NUMBER OF STILL BIRTHS

CHAPTER SIX

THE HIGH RISK HOME

Introduction

The concept of a high risk home is to help identify homes in the study which, either by definition or by demonstrated association with the dependent study variables is a home where the occupants would be expected to have lower health status or to be at an increased risk of infection, disease, or other negative health impact. In this chapter an attempt is made to classify such houses by generating new composite variables that, based on current knowledge of hygiene and sanitation, would be environments expected to foster poor health in terms measured here. The results from section 5.1 on house age provided several insights and suggestions as to what might be a high risk home in terms of infection by any protozoan. The starting point here, however, is a definitional one. Their dependent variables are exploited and used as evaluators of different housing conditions.

6.1 Proposed Definition of a High Risk Home

A high risk home, by definition, was a home that had the least desirable environmental features. This home was a combination of:

1) Mud or M/B
2) No latrine
3) Canal water supply
4) Inside stable
5) Dung as cooking fuel
6) No paint on walls
7) Attached on three sides
8) Two rooms or less

9) Illiterate head of house
10) Unemployed head of house
11) Earth floor
12) Kerosine light

Tabulations were made to determine the percentage of homes with all these features or combinations of these features. Since the number of all different strata were calculated to be 3456, selected combinations were made. These combinations are shown on Table 6.1 A. When all 12 characteristics were selected no cases could be found. Removal of various characteristics from the selection increased the number of homes identified and the corresponding number of individuals. The percentage of homes identified as a proportion of the total is also given.

6.2 Infection and the High Risk Home

Combination number 2 (see Table 6.1 A) had very few cases or individuals. Infection was more frequent in the indicated group compared to those who did not have the combination of characteristics of number 2.

Combination number 3 had even fewer cases as there were few homes without latrines which also obtained canal water. The distribution of infection was the same as for number 2.

Number 4 had many cases and was significantly associated with increased infection with any protozoan. The odds ration was not great, 1:11. The number of cases was reduced for number 5; however, for protozoan infections the results showed a more elevated odds ratio, 1:32. The actual distribution of infection prevalence was 36.1% in individuals not living in homes with the respective features

TABLE 6.1 A

Broadside Reference: High Risk Home Table

Characteristic	Combination Code Numbers Star Indicates That Feature Was Included in the Selection									
	1	2	3	4	5	6	7	8	9	10
Mud or Mud brick .	*	*	*	*	*	*			*	
No latrine	*	*	*							
Canal water supply . .	*		*					*		
Stable inside . .	*	*								
Dung as fuel . .	*	*			*					
No paint on walls .	*									
Attached 3 sides . .	*									
Two rooms or less . .	*									

Characteristic	Combination Code Numbers Star Indicates That Feature Was Included in the Selection									
	1	2	3	4	5	6	7	8	9	10
Old house . . .	*	*			*	*	*	*		*
No job/illiterate head of house .	*								*	*
Earth floor . . .	*	*		*	*	*		*	*	
Kerosine light . . .		*								
Number of homes .	0	29	16	1767	166	806	1006	66	110	68
%age as total .	0	1	0.6	63	6	29	36	2	4	2
Number of cases .	0	128	64	7433	611	3230	4059	312	117	73

Characteristic	Combination Code Numbers Star Indicates That Feature Was Included in the Selection									
	1	2	3	4	5	6	7	8	9	10
Odds ratio for infection with any protozoan . . .	0	<1	<1	1.11	1.32	1.16	1.26	<1	1.61	1.51

and 42.7% infected when the feature was present. There was a substantial increase in cases when dung was dropped from the list for the next combination, Number 6. Otherwise 6 was the same as 5. Association strength was reduced from 1.32 to 1.16 for protozoan infections. Old house alone, number 7, increased the association back to 1.26, indicating that mud housing or earth floors were depressing this association. This led to testing number 8, which deleted the association completely.

When combination number 9 was examined the strongest association measured (1.61) was observed. The distribution of prevalence was 41.1% to 51.8% in the non-risk and risk categories, respectively. The lack of employment by the head of household combined with illiteracy and mud housing had a notable effect on risk. Combination number 10 tested old houses with unemployed and illiteracy with significant results and an odds ratio of 1.51. The number of cases was small. Thirty-six and three-tenths percent and 45.6% was the distribution of infection between the two comparison groups. Numerous other combinations were tested, but without improving the strength of association found already.

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APPENDIX A

```
dis int f=*t*
dis int f=water
dis int f=var
res sprint=*sink*
rel *print*
con *t* posn=*1*
read int water f=*t*
con *t* posn=*1*
read int htwt f=*t* v=8,72,70,3001-3003,31-32
rel *t*
con *print* hold route=soph
res sprint=*print*
set water
one by v=431,432,433,434 st=v70 c=v2:1*v72 op=marg
one by v=* st=v72 c=v2:1 op=marg
two v=447,448,449:432,433,434 c=v2:1*v70:17 op=row,col
two v=431,461 c=v2:1*v70:4 op=row,col
two by v=446;447,448,449 st=v72 c=v2:1 op=row,col
two by v=* st=v70 c=v2:1*v72 op=row,col
res sprint=*sink*
dis *print*
stop
con *print* hold route=soph
res sprint=*print*
set water
one by c=v8:1-20 st=v72
res sprint=*sink*
dis *print*
stop
con *print* hold route=soph
res sprint=*print*
set htwt
student v=31,32 st=v3001 c=v8:1
student v=* st=* c=v8:2
student v=* st=* c=v8:3
student v=* st=* c=v8:4
student v=* st=* c=v8:5
student v=* st=* c=v8:6
student v=* st=* c=v8:7
student v=* st=* c=v8:8
student v=* st=* c=v8:9
student v=* st=* c=v8:10
student v=* st=* c=v8:11
student v=* st=* c=v8:12
student v=* st=* c=v8:13
student v=* st=* c=v8:14
student v=* st=* c=v8:15
student v=* st=* c=v8:16
student v=* st=* c=v8:17
student v=* st=* c=v8:18
student v=* st=* c=v8:19
student v=* st=* c=v8:20
```

```
res sprint=*sink*
dis *print*
stop
code v7000=index(v72) val=4,1,2,3 l=*
write complete f=-a fo=(4f10.4) v=3001,7000,8,31 c=v8:1-20
write complete f=-b fo=(4f10.4) v=3001,7000,8,32 c=v8:1-20
write complete f=-c fo=(3f10.4) v=3001,7000,31 c=v8:1
write complete f=-d fo=(3f10.4) v=3001,7000,31 c=v8:2
write complete f=-e fo=(3f10.4) v=3001,7000,31 c=v8:3
write complete f=-f fo=(3f10.4) v=3001,7000,31 c=v8:4
write complete f=-g fo=(3f10.4) v=3001,7000,31 c=v8:5
write complete f=-h fo=(3f10.4) v=3001,7000,31 c=v8:6
write complete f=-i fo=(3f10.4) v=3001,7000,31 c=v8:7
write complete f=-j fo=(3f10.4) v=3001,7000,31 c=v8:8
write complete f=-k fo=(3f10.4) v=3001,7000,31 c=v8:9
write complete f=-l fo=(3f10.4) v=3001,7000,31 c=v8:10
write complete f=-m fo=(3f10.4) v=3001,7000,31 c=v8:11
write complete f=-n fo=(3f10.4) v=3001,7000,31 c=v8:12
write complete f=-o fo=(3f10.4) v=3001,7000,31 c=v8:13
write complete f=-p fo=(3f10.4) v=3001,7000,31 c=v8:14
write complete f=-q fo=(3f10.4) v=3001,7000,31 c=v8:15
write complete f=-r fo=(3f10.4) v=3001,7000,31 c=v8:16
write complete f=-s fo=(3f10.4) v=3001,7000,31 c=v8:17
write complete f=-t fo=(3f10.4) v=3001,7000,31 c=v8:18
write complete f=-u fo=(3f10.4) v=3001,7000,31 c=v8:19
write complete f=-v fo=(3f10.4) v=3001,7000,31 c=v8:20
write complete f=-aa fo=(3f10.4) v=3001,7000,32 c=v8:1
write complete f=-bb fo=(3f10.4) v=3001,7000,32 c=v8:2
write complete f=-cc fo=(3f10.4) v=3001,7000,32 c=v8:3
write complete f=-dd fo=(3f10.4) v=3001,7000,32 c=v8:4
write complete f=-ee fo=(3f10.4) v=3001,7000,32 c=v8:5
write complete f=-ff fo=(3f10.4) v=3001,7000,32 c=v8:6
write complete f=-gg fo=(3f10.4) v=3001,7000,32 c=v8:7
write complete f=-hh fo=(3f10.4) v=3001,7000,32 c=v8:8
write complete f=-ii fo=(3f10.4) v=3001,7000,32 c=v8:9
write complete f=-jj fo=(3f10.4) v=3001,7000,32 c=v8:10
write complete f=-kk fo=(3f10.4) v=3001,7000,32 c=v8:11
write complete f=-ll fo=(3f10.4) v=3001,7000,32 c=v8:12
write complete f=-mm fo=(3f10.4) v=3001,7000,32 c=v8:13
write complete f=-nn fo=(3f10.4) v=3001,7000,32 c=v8:14
write complete f=-oo fo=(3f10.4) v=3001,7000,32 c=v8:15
write complete f=-pp fo=(3f10.4) v=3001,7000,32 c=v8:16
write complete f=-qq fo=(3f10.4) v=3001,7000,32 c=v8:17
write complete f=-rr fo=(3f10.4) v=3001,7000,32 c=v8:18
write complete f=-ss fo=(3f10.4) v=3001,7000,32 c=v8:19
write complete f=-tt fo=(3f10.4) v=3001,7000,32 c=v8:20
write int f=5eu4:variable v=3001-3003,31,32,72,8
con *print* hold route=soph
res sprint=*print*
dis int f=5eu4:variable
res sprint=*sink*
rel *print*
finish
```

```
code v700=1 c=v7:1 l=*
code v700=2 c=v7:2 l=*
code v700=3 c=v7:3 l=*
code v700=4 c=v7:4 l=*
code                    v700=5                    c=v7:5,6,7,8,9
l=relate(head,wife,male,female,other)
code v2600=1 c=v5:5-14*v26:1 l=*
code v2600=2 c=v26:2*v5:6-15 l=*
code v2600=3 c=v26:3*v5:5-14 l=*
code v2600=4 c=v26:4*v5:5-14 l=*
code v2600=5 c=v26:5*v5:5-14 l=*
code v2600=6 c=v26:6*v5:5-14 l=*
code v2600=7 c=v26:7*v5:5-14 l=*
code v2600=8 c=v26:8*v5:5-14 l=*
code v2600=9 c=v26:9*v5:5-14 l=*
code v2600=10 c=v26:10*v5:5-14*v21:6 l=*
code v2600=11 c=v26:11*v5:5-14*v21:6 l=*
code v2600=12 c=v26:13*v5:5-14 l=*
code v2600=13 c=v26:14
code v4010=1 c=v401:4 l=*
code v4010=2 c=v401:5 l=*
code v4010=3 c=v401:8 l=*
code v4010=4 c=v401:9 l=*
code v4010=5 c=v401:11 l=*
code v4010=6 c=v401:12 l=*
code                    v4010=7                    c=v401:1-3,6,7,10
l=build(brick,mud,br.mud,br.w,br.m.w,m.w,other)
code v4090=1 c=v409:4 l=*
code v4090=2 c=v409:5 l=*
code v4090=3 c=v409:6 l=*
code v4090=4 c=v409:7 l=*
code v4090=5 c=v409:8 l=*
code v4090=6 c=v409:9 l=*
code v4090=7 c=v409:10 l=*
code v4090=8 c=v409:11 l=*
code v4090=9 c=v409:12 l=*
code                    v4090=10                    c=v409:1-3
l=floor(erth,conc,tile,wood,erco,et,ew,ect,ct,other)
code v4110=1 c=v411:3 l=*
code v4110=2 c=v411:4 l=*
code v4110=3 c=v411:5 l=*
code v4110=4 c=v411:8 l=*
code                    v4110=5                    c=v411:1,2,6,7,9-12
l=light(k.ot,elec,ker,ek,other)
code v4150=1 c=v415:4 l=*
code v4150=2 c=v415:5 l=*
code v4150=3 c=v415:6 l=*
code v4150=4 c=v415:7 l=*
code                    v4150=5                    c=v415:1-3,8-12
l=stable(in,out,none,both,noinfo)
code v6340=1 c=v634:1 l=*
code v6340=2 c=v634:2 l=*
code v6340=3 c=v634:3 l=*
code v6340=4 c=v634:5 l=*
```

```
code v6340=5 c=v634:6 l=*
code v6340=6 c=v634:8 l=*
code v6340=7 c=v634:9 l=*
code                    v6340=8                    c=v634:4,7
l=zir(metal,cerami,earth,mcer,mearth,mce,ceart,other)
code v6360=1 c=v636:1*v637:1 l=*
code v6360=2 c=v636:1*v637:2 l=*
code v6360=3 c=v636:2*v637:2 l=latrine(used,notuse,no)
code v6400=1 c=v640:1 l=*
code v6400=2 c=v640:2 l=*
code v6400=3 c=v640:3 l=*
code v6400=4 c=v640:5 l=*
code v6400=5 c=v640:6 l=*
code v6400=6 c=v640:8 l=*
code v6400=7 c=v640:9 l=*
code                     v6400=8                   c=v640:4,7
l=pit.type(bore,pit,walls,bopit,bowal,bopiwa,piwal,other)
code v4180=1 c=v418:1 l=*
code v4180=2 c=v418:2 l=*
code v4180=3 c=v418:3 l=*
code v4180=4 c=v418:4 l=*
code v4180=5 c=v418:5 l=*
code v4180=6 c=v418:6 l=*
code v4180=7 c=v418:7 l=*
code v4180=8 c=v418:8 l=*
code v4180=9 c=v418:9 l=*
code v4180=10 c=v418:10 l=*
code v4180=11 c=v418:11 l=*
code v4180=12 c=v418:12 l=*
code                    v4180=13                    c=v418:13
l=cook(wd,owd,od,gas,oil,wood,dung,go,gw,gd,gow,ow,other)

read int fi=*t* v=2,70,71,300-310,313-321,5,8,21,26,7
trans v1000=linear v=70,71 rel=10000,1 l=fam id
trans v1001=linear v=1000,2 rel=100,1 l=indiv.id
code res=1002,1003 fu=ordinal v=1000,1001 l=fam ord,ind ord
code by summ st=v1003 v1004=order sizes=* l=position
code v9999=order sizes=4*4000 l=* st=none
trans  by  summ st=v9999 v3002=match v=313-321 rel=9*2 l=any
pro
code v3002=cuts(v3002) po=,.5, l=any pro(no,yes) st=*
trans by summ v3003=match v=300-310 rel=11*2 l=any worm st=*
code v3003=cuts(v3003) po=,.5, l=any worm(no,yes)
code v3001=st st=v3002*v3003 l=*
code v3001=st st=v3001:1,(2-4) l=buggy(no,yes)
del v=300-310,313-321,9999
compute fam st=v1002*v1004:1 res=70,71 fu=* v=70,71 l=*
compute fam st=same v101=count(v0) val=* l=total#
compute fam st=same res=102-104 fu=count  val=2  v=2001-2003
l=buggy#,any pro#,any worm#
trans fam res=112-114 fu=* v=102-104 l=*
trans res=112-114 fu=replace(0.) l=*
trans  fam  res=105-107 fu=divide v=112-114;101 l=buggy%,any
pro%,any worm%
```

```
cre -fam type=seq size=5000p
write int fi=-fam v=70,71,101-107,112-114 st=none c=all
del fam v=all
set data
compute fam v108=count(v0) val=*  st=v1002*v1004:1  c=v7:3,4
l=kid#
compute fam v109=mean v=8 c=v7:3,4 l=kid age  st=same
compute fam  st=*  c=v7:1,2*v21:4-6  v110=count(v0)  val=*
l=literacy
compute fam st=* v111=v26 c=v7:1 l=*
read int fi=-internal
v=401,402,407,409,411,413,414,415,418,419,420,423
compute fam st=v1002*v1004:1
res=401,402,407,409,411,413,414,415,418,419,420,423 fu=*
 v=401,402,407,409,411,413,414,415,418,419,420,423 l=*
del   v=401,402,407,409,411,413,414,415,418,419,420,423
code fam v110=cuts(v110) po=,.5, l=literate(no,yes)
write int fam fi=-fam
v=401,402,407,409,411,413,414,415,418,419,420,423,108-111
del fam
v=401,402,407,409,411,413,414,415,418,419,420,423,108-111
read data int fi=-internal v=426-445
compute fam  res=426-445 fu=* v=426-445 l=* st=v1002*v1004:1
del v=426-445
write int fam v=426-445 fi=-fam
del fam v=426-445
read data int  fi=-internal v=446-465
compute fam  res=446-465 fu=* v=446-465 l=* st=v1002*v1004:1
del v=446-465
write int fam v=446-465 fi=-fam
read data int  fi=-internal v=634-640
compute fam res=634-640 fu=* v=634-640 l=* st=v1002*v1004:1
write int fam v=634-640 fi=-fam
del fam v=all
del data v=all
comment -- setup to do analysis at family level
read int fi=-fam v=101-114,70,71
hist v=101,112-114,108 int=/1 op=nonempty,hist%
hist v=105-107 int=* op=same
twoway v=102-104;101 op=row
stud st=v110 v=105-107
anova st=v111 v=105-107
del v=112-114,110,111
read int fi=-fam
v=401,402,407,409,411,413,414,415,418,419,420,423
anova st=v401 v=105-107 c=v70:1-4,10-20
anova * st=v402
anova * st=v407
anova * st=v409
anova * st=v411
anova * st=v413
anova * st=v414
anova * st=v415
anova * st=v418
```

```
anova * st=v419
anova * st=v420
anova * st=v423
del v=401,402,407,409,411,413,414,415,418,419,420,423
read data int fi=-fam v=426-445
stud * st=v426 v=105-107  c=v70:1-4,10-20
stud * st=v427
stud * st=v428
stud * st=v429
stud * st=v430
stud  * st=v431
stud * st=v432
stud * st=v433
stud * st=v434
stud * st=v435
stud * st=v436
stud * st=v437
stud * st=v438
stud * st=v439
stud * st=v440
stud * st=v441
stud * st=v442
stud * st=v443
stud * st=v444
stud * st=v445
del v=426-445
read int fi=-fam v=446-465
stud * v=105-107 st=v446 c=v70:1-4,10-20
stud * st=v447
stud * st=v448
stud * st=v449
stud * st=v450
stud * st=v451
stud * st=v452
stud * st=v453
stud * st=v454
stud * st=v455
stud * st=v456
stud * st=v457
stud * st=v458
stud * st=v459
stud * st=v460
stud * st=v461
stud * st=v462
stud * st=v463
stud * st=v464
stud * st=v465
del v=446-465
read int fi=-fam v=634-640
anova * st=v634 v=105-107 c=v70:1-4,10-20
anova * st=v635
stud * st=v636
stud * st=v637
stud * st=v638
```

```
anova * st=v639
anova * st=v640

comment file name=count
compute V3150=count(V315,1) ST=V71 l=Coli-
compute V3151=count(V315,2) ST=V71 l=Coli+
compute V1000=count(V2) ST=V71 l=Famsize
compute V3140=count(V314,1) ST=V71 l=Histo-
compute V3141=count(V314,2) ST=V71 l=Histo+
compute V3130=count(V313,1) ST=V71 l=Giar-
compute V3131=count(V313,2) ST=V71 l=Giar+
compute V1600=count(V16,1) ST=V71 l=S.h.-
compute V1601=count(V16,2) ST=V71 l=S.h.+
compute V1700=count(V17,1) ST=V71 l=S.m.-
compute V1701=count(V17,2) ST=V71 l=S.m.+

con *print* hold route=soph
RUN STAT:BMDP2V 1=-Q 2=-QQ 6=*PRINT* 7=-A
PROBLEM        TITLE        IS        'ANALYSIS        FOR
HOUSE,BUGGY,REGION,AGE1,HEIGHT'./
INPUT VARIABLES ARE 5.
UNIT IS 7.
CASES ARE 1004.
FORMAT IS '(5F10.4)'./
VARIABLE NAMES ARE HOUSE,BUGGY,REGION,AGE1,HEIGHT./
DESIGN FORM IS '3G,X,Y'./
END/
list covar *print*
rel *print*

con *print* hold route=nubs
res sprint=*print*
two    complete    v=4500;16,17,300-304,307,313-318    l=.95
op=col,test,expected head=unit 19 2/12/81
rcorr   v=16,17,300-304,307,313-318   op=tau,rho,concordance
head=same
two   complete   v=637-638,640-647;636   op=col,row   c=v2:1
head=same
histo v=7200 int=15 op=hist% c=latrine:yes*v2:1  head=same
one v=401-465,501-509,636-647 op=marg c=v2:1 head=same
two  complete  v=401;425,426,431,436,441,446,451,461  op=col
c=v2:1 head=same
two complete v=418;409,401 op=col,row c=v2:1 head=same
two complete v=413;414,402 op=col c=v2:1 head=same
one v=21-25 op=marg c=all head=same
one v=26 op=marg c=v26:1-14 head=same
two    complete   v=21,26   c=all   op=col,row,test,expected
head=unit
rcorr v=age,yr.live op=tau,rho
res sprint=*sink*
rel            *print*            code            v7201=st
st=v7200:(1-10),(11-20),(21-30),(31-40),(41-50),(51-60),
(61-70),(71-76)  l=h.dates  code  v1=1  c=v2:1*region  l=gdc
comment file ammended to analyze  5/12 age infection h.dates
```

```
mount c8078a 9tp *t* ring=out vol=vija 'vija' con *T*
posn=*1* read int v=313,314 f=*t* rel *T* read int
v=72,70,3001-3003,7201,3010 f=data* read int v=315,5,8
f=5eu4:variable con *print* hold route=soph res
sprint=*print* two v=7201,3002 c=region*coli op=col,test
l=.9 two v=7201,3002 c=region op=col,test l=.9 two by v=same
op=col,test st=v72 c=coli two by v=same op=col,test st=v72
c=region two by v=same op=col,test st=v70 c=region two
v=age;3001-3003 c=region st=none op=col,test two by v=same
op=col,test st=v70 c=region*coli two by v=same op=col,test
st=v70 c=region two v=8;3001-3003 op=col,test st=none
c=region*coli*v8:1-15 two v=8;3001-3003 op=col,test st=none
c=region*v8:1-15 two by v=same op=col,test st=v70 c=same two
v=7201;313-315 c=region st=none op=col,test l=.9 con f=-
midas list -midas *print* res sprint=*sink* dis *print*

mount c8078a 9tp *t* ring=in vol=vija 'vija'
con *t* posn=*1*
read int f=*t*
read int v=300-310,313-320,3001-3003,3005-3006,636,6360,2
f=*t*
rel *t*
con *print* hold route=soph
res sprint=*print*
one by v=300-310,313-320,3001-3003,3005-3006 c=all st=v72
op=marg
two by
v=426,431,436,441,446;300-310,313-320,3001-3003,3005-3006
c=all st=v72 op=col,tests
one v=636 c=v2:1 op=marg
one v=6360 c=v2:1 op=marg
two by v=6360;300-310,313-320,3001-3003,3005-3006,16,17
c=all st=v72 op=col,tests
write * v=313-320,3002 c=100-125
write * v=300-310,3003 c=100-125
one by v=426,431 c=v436:1*v441:1*v446:1*v2:1 st=v70*v72
op=marg
one by v=6360 st=v70 c=v2:1*v72:2 op=marg
one by v=17 st=v70 c=v2:1*v72:2 op=marg
two by v=426,431;300-310,313-320,3001-3003,3005-3006,16,17
c=v436:1*v441:1*v446:1*v2:1 st=v70*v72 op=col,tests
two by v=same c=v2:1 st=same op=same
two by v=436,441;300-310,313-320,3001-3003,3005-3006,16,17
c=v426:1*v431:1*v446:1*v2:1 st=same op=same
two by v=446;300-310,313-320,3001-3003,3005-3006,16,17
c=v426:1*v431:1*v436:1*v441:1*v2:1 st=same op=same
two by v=436;446 st=v70 c=v2:1*v72:3 op=row,tests
one v=426,431,446,451,456,461 c=v436:1*v441:1*v2:1*v70:11
op=marg
des v=31,32
stop
trans v3333=v31/10 c=all l=h age
trans v3444=v32/10 c=all l=w age
trans v3101=v3333/v8 c=v31:1-2500 l=h age
```

```
trans v3201=v3444/v8 c=v32:1600 l=w age
trans v3102=v3101/v3201 c=all l=h w
des by v=3101 st=v426*v72*v70
des by v=3201 st=v426*v72*v70
des by v=3102 st=v426*v72*v70
des by v=3101 st=v431*v72*v70
des by v=3201 st=v431*v72*v70
des by v=3102 st=v431*v72*v70
des by v=3101 st=v436*v72*v70
des by v=3201 st=v436*v72*v70
des by v=3102 st=v436*v72*v70
des by v=3101 st=v441*v72*v70
des by v=3201 st=v441*v72*v70
des by v=3102 st=v441*v72*v70
des by v=3101 st=v446*v72*v70
des by v=3201 st=v446*v72*v70
des by v=3102 st=v446*v72*v70
anova st=v426 v=3101 c=v72:3*v8:1-20
anova st=v426 v=3201 c=v72:3*v8:1-20
anova st=v426 v=3102 c=same
anova st=v431 v=3101 c=same
anova st=v431 v=3201 c=same
anova st=v431 v=3102 c=same
anova st=v436 v=3101 c=same
anova st=v436 v=3201 c=same
anova st=v436 v=3102 c=same
anova st=v441 v=3101 c=same
anova st=v441 v=3201 c=same
anova st=v441 v=3102 c=same
anova st=v446 v=3101 c=same
anova st=v446 v=3201 c=same
anova st=v446 v=3102 c=same
mts
des by v=3101 st=v3001*v72*v70
des by v=3201 st=v3001*v72*v70
des by v=3102 st=v3001*v72*v70
des by v=3101 st=v3002*v72*v70
des by v=3201 st=v3002*v72*v70
des by v=3102 st=v3002*v72*v70
des by v=3101 st=v3003*v72*v70
des by v=3201 st=v3003*v72*v70
des by v=3102 st=v3003*v72*v70

comment file=fam/p/hdate to set midas up for testing fam and

house
MOUNT C7143C  9TP *T* RING=out VOL=GARFE2 'GARFE2'
run *fs 0=*T*
restore family -f
mount c8078a 9tp *t* ring=out vol=vija 'vija'
con *T* posn=*1*
 stat:midas
read data int v=72,1002,1004,7200,7201 f=*T*
rel *T*
```

```
read fam int v=105-114,70,71 f=-f
des -f ok
set data
compute fam st=v1002*v1004:1 v=7200,7201,72 res=7200,7201,72
fu=* l=*
set fam
write * v=105-107,7200,7201 c=v70:12
regress v=105-107;7200,7201 c=region*v7200:1-76
set data
set fam
write int v=all f=k8q2:1002*

r *fs 0=*t*
restore family -family
stop
con *t* posn=*1*
read int int v=1002,1004,3001,3002 f=*t*
rel *t*
compute fam v105=max v=3001 l=max bug st=v1002*v1004:1
compute fam v106=max v=3002 l=max pro st=v1002*v1004:1
write * v=3001,105,3002,106 c=v0:50-80*v1004:1
del int v=all
read int fam f=-family
v=7,5,26,401,409,411,415,634,636,637,640,418
code v3005=cuts(v105) po= ,2.5,
code v3006=cuts(v106) po= ,2.5,
write int f=-family
MOUNT C7143C  9TP *T* RING=out VOL=GARFE2 'GARFE2'
r *fs 0=*t*
save -family family
stop

comment:   this file creates highrisk variables and analyzes

them against buggy,anypro, and anyworm
code v2140=1 c=v72 l=dumbhead(no,yes)
code v2140=2 c=v7:1*v21:4 l=dumbhead(no,yes)
code v2610=1 c=v72 l=nojob(no,yes)
code v2610=2 c=v7:1*v26:1 l=nojob(no,yes)
one v=2140,2610 op=marg
con *print* hold route=soph
res sprint=*print*
read int f=data* v=1,72,4010,4090,4180,7201,3001,3002,3003
read int f=5eu4:variable v=2140,2610
mount c8078a 9tp *t* ring=in vol=vija 'vija'
con *t* posn=*1*
read int f=*t* v=446,6360,4110,4150
rel *t*
code v4500=1 c=v72 l=highrisk(no,yes)
code v4500=2 l=highrisk(no,yes)
code v4501=1 c=v72 l=hirisk2(no,yes)
code v4501=2 c=v72*v4010:2*v6360:3*v446:2 l=hirisk2(no,yes)
code v4502=1 c=v72 l=*
code v4502=2 c=v72*v4010:2*v4090:1 l=hirisk3(no,yes)
```

```
code v4503=1 c=v72 l=*
code     v4503=2     c=v72*v4010:2*v4090:1*v4180:7*v7201:1-4
l=hirisk4(no,yes)
code v4504=1 c=v72 l=*
code         v4504=2         c=v72*v4010:2*v4090:1*v7201:1-4
l=hirisk5(no,yes)
code v4505=1 c=v72 l=*
code v4505=2 c=v72*v7201:1-4 l=hirisk6(no,yes)
code v4506=1 c=v72 l=*
code         v4506=2          c=v72*v4090:1*v7201:1-4*v446:2
l=hirisk7(no,yes)
code v4507=1 c=v72 l=*
code      v4507=2      c=v72*v4010:2*v4090:1*v2140:2*v2610:2
l=hirisk8(no,yes)
code v4508=1 c=v72 l=*
code v4508=2 c=v72*v2140:2*v2610:2*v446:2 l=hirisk9(no,yes)
code v4509=1 c=v72 l=*
code  v4509=2  c=v72*v4010:2*v4090:1*v6360:3*v2140:2*v2610:2
l=hirisk10(no,yes)
code 4510=1 c=v72 l=*
code                                                    4510=2
c=v72*v4010:2*v4090:1*v4180:7*v6360:3*v2140:2*v2610:2
l=hirisk11(no,yes)
code 4513=1 c=v72 l=*
code 4513=2 c=v72*v4010:2*v4090:1*v6360:3 l=hirisk12(no,yes)
code 4512=1 c=v72 l=*
code         4512=2          c=v72*v7201:1-4*v2140:2*v2610*2
l=hirisk13(no,yes)
two c=all st=none op=row,col,tests
res sprint=*print*
list highrisk *print*
rel *print*
des by v=3250 st=4500
des by v=3250 st=4501
des by v=same st=4502
des by v=same st=4503
des by v=same st=4504
des by v=same st=4505
des by v=same st=4506
des by v=8 c=v72 st=v4090
des by v=same c=same st=v6360
des by v=same c=same st=v4010
des by v=same c=same st=v7201

comment file name=hwage
mount c3078a 9tp *t* ring=in vol=vija 'vija'
con *t* posn=*1*
read int f=*t* v=2,8,31,32,72,3001-3003,300-310,313-320
rel *t*
con *print* hold route=soph
res sprint=*print*
covar v=31,32;8 st=v3001*v72 c=v8:(1-20)
covar v=* st=v3002*v72 c=*
covar v=* st=v3003*v72 c=*
```

```
covar v=32;31 st=v3001*v72 c=*
covar v=* st=v3002*v72 c=*
covar v=* st=v3003*v72 c=*
code r=1300-1310,1313-1320 v=300-310,313-320 c=all f=* l=*
missing v=1300-1310,1313-1320 val=2
code v2001=count v=1300-1310 l=n.worms
code v2002=count v=1313-1320 l=n.protoz
code v2003=v2001+v2002 l=n.bugs
one by v=2001-2003 op=marg c=v8:1-20 st=v72
describe by st=* v=* c=*
distribution by v=31,32 prob=.25,.5,.75 st=v8:1-20*v72 c=all
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:1*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:2*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:3*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:4*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:5*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:6*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:7*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:8*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:9*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:10*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:11*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:12*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:13*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:14*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:15*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:16*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:17*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:18*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:19*v72:1 l=*
code v200=cuts(v31) points=,p.25,p.5,p.75, c=v8:20*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:1*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:2*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:3*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:4*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:5*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:6*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:7*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:8*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:9*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:10*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:11*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:12*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:13*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:14*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:15*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:16*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:17*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:18*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:19*v72:1 l=*
code v200=cuts(v32) points=,p.25,p.5,p.75, c=v8:20*v72:1 l=*
tsquare v=2001-2003 st=adj.ht
tsquare v=* st=adj.wt
stop
```

```
dis int f=*t*
res sprint=*sink*
dis *print*

mount c8078a 9tp *t* ring=in vol=vija 'vija'
con *t* posn=*1*
read int v=636,637,418,414,413,2,70,71,300-310,313-321 f=*t*
rel *t*
write * v=636,6360,637 c=50-60
code v72=1 c=v70:5-9 l=*
code v72=2 c=v70:16-20 l=*
code v72=3 c=v70:11-15 l=*
code v72=4 c=v70:1-4,10 l=region(nubes,delta,middle,upper)
trans v4140=v414/v413 c=v2:1 l=pop.room
code v3005=cuts(v3001) po= ,2.5,  l=bugs(<3,>3)
code v3006=cuts(v3002) po= ,2.5,  l=pro(<3,>3)
mount c8078a 9tp *t* ring=in vol=vija 'vija'
mts

read9int9v=72,89f=data*
read9int9v=31,32,32239f=k8q2:zscores*
con9*print*9hold9route=soph
res9sprint=*print*
trans9v3110=v31-729.7291=ht9c=v72*v3223*v31:440-1940*v8:1
trans9v3111=v3110/262.0891=htz9c=*
trans9v3110=v31-783.5891=ht9c=v72*v3223*v31:440-1940*v8:2
trans9v3111=v3110/181.3491=htz9c=*
trans9v3110=v31-879.1591=ht9c=v72*v3223*v31:440-1940*v8:3
trans9v3111=v3110/173.0891=htz9c=*
trans9v3110=v31-958.9691=ht9c=v72*v3223*v31:440-1940*v8:4
trans9v3111=v3110/174.5591=htz9c=*
trans9v3110=v31-1047.991=ht9c=v72*v3223*v31:440-1940*v8:5
trans9v3111=v3110/169.5791=htz9c=*
trans9v3110=v31-1103.691=ht9c=v72*v3223*v31:440-1940*v8:6
trans9v3111=v3110/165.3191=htz9c=*
trans9v3110=v31-1172.391=ht9c=v72*v3223*v31:440-1940*v8:7
trans9v3111=v3110/146.8391=htz9c=*
trans9v3110=v31-1187.491=ht9c=v72*v3223*v31:440-1940*v8:8
trans9v3111=v3110/137.1391=htz9c=*
trans9v3110=v31-1232.091=ht9c=v72*v3223*v31:440-1940*v8:9
trans9v3111=v3110/119.6091=htz9c=*
trans9v3110=v31-1285.091=ht9c=v72*v3223*v31:440-1940*v8:10
trans9v3111=v3110/137.2791=htz9c=*
trans9v3110=v31-1310.791=ht9c=v72*v3223*v31:440-1940*v8:11
trans9v3111=v3110/108.8591=htz9c=*
trans9v3110=v31-1347.491=ht9c=v72*v3223*v31:440-1940*v8:12
trans9v3111=v3110/122.9391=htz9c=*
trans9v3110=v31-1398.491=ht9c=v72*v3223*v31:440-1940*v8:13
trans9v3111=v3110/120.4491=htz9c=*
trans9v3110=v31-1438.491=ht9c=v72*v3223*v31:440-1940*v8:14
trans9v3111=v3110/102.191=htz9c=*
trans9v3110=v31-1498.391=ht9c=v72*v3223*v31:440-1940*v8:15
trans9v3111=v3110/109.1691=htz9c=*
trans9v3210=v32-108.8591=wt9c=v72*v3223*v31:440-1940*v8:1
```

```
trans9v3211=v3210/131.0491=wtz9c=*
trans9v3210=v32-113.5891=wt9c=v72*v3223*v31:440-1940*v8:2
trans9v3211=v3210/85.67691=wtz9c=*
trans9v3210=v32-142.3191=wt9c=v72*v3223*v31:440-1940*v8:3
trans9v3211=v3210/82.75491=wtz9c=*
trans9v3210=v32-166.4691=wt9c=v72*v3223*v31:440-1940*v8:4
trans9v3211=v3210/99.16691=wtz9c=*
trans9v3210=v32-188.9591=wt9c=v72*v3223*v31:440-1940*v8:5
trans9v3211=v3210/98.41491=wtz9c=*
trans9v3210=v32-208.4791=wt9c=v72*v3223*v31:440-1940*v8:6
trans9v3211=v3210/97.82591=wtz9c=*
trans9v3210=v32-237.8991=wt9c=v72*v3223*v31:440-1940*v8:7
trans9v3211=v3210/108.9291=wtz9c=*
trans9v3210=v32-241.8391=wt9c=v72*v3223*v31:440-1940*v8:8
trans9v3211=v3210/92.38091=wtz9c=*
trans9v3210=v32-255.6391=wt9c=v72*v3223*v31:440-1940*v8:9
trans9v3211=v3210/82.41491=wtz9c=*
trans9v3210=v32-288.5891=wt9c=v72*v3223*v31:440-1940*v8:10
trans9v3211=v3210/101.8891=wtz9c=*
trans9v3210=v32-300.6591=wt9c=v72*v3223*v31:440-1940*v8:11
trans9v3211=v3210/74.72691=wtz9c=*
trans9v3210=v32-324.1391=wt9c=v72*v3223*v31:440-1940*v8:12
trans9v3211=v3210/92.42491=wtz9c=*
trans9v3210=v32-367.7391=wt9c=v72*v3223*v31:440-1940*v8:13
trans9v3211=v3210/104.9191=wtz9c=*
trans9v3210=v32-394.2491=wt9c=v72*v3223*v31:440-1940*v8:14
trans9v3211=v3210/79.2491=wtz9c=*
trans9v3210=v32-449.2191=wt9c=v72*v3223*v31:440-1940*v8:15
trans9v3211=v3210/111.5891=wtz9c=*
code9v3150=cuts(v31)9c=v72*v31:440-1940*v3223*v8:1-159
points=,780,940,1030,1120,1200,1260,1320,1405,1510,91=hwz
trans9v3249=v32-86.28291=hw9c=v72*v3223*v31:440-1940*v3150:1
trans9v3250=v3249/28.54491=hwz9c=*
trans9v3249=v32-129.3791=hw9c=v72*v3223*v31:440-1940*v3150:2
trans9v3250=v3249/30.50091=hwz9c=*
trans9v3249=v32-163.4491=hw9c=v72*v3223*v31:440-1940*v3150:3
trans9v3250=v3249/39.06691=hwz9c=*
trans9v3249=v32-191.7391=hw9c=v72*v3223*v31:440-1940*v3150:4
trans9v3250=v3249/45.22191=hwz9c=*
trans9v3249=v32-208.1191=hw9c=v72*v3223*v31:440-1940*v3150:5
trans9v3250=v3249/40.46991=hwz9c=*
trans9v3249=v32-251.5891=hw9c=v72*v3223*v31:440-1940*v3150:6
trans9v3250=v3249/49.39191=hwz9c=*
trans9v3249=v32-276.5291=hw9c=v72*v3223*v31:440-1940*v3150:7
trans9v3250=v3249/49.49591=hwz9c=*
trans9v3249=v32-322.1091=hw9c=v72*v3223*v31:440-1940*v3150:8
trans9v3250=v3249/60.79991=hwz9c=*
trans9v3249=v32-394.9691=hw9c=v72*v3223*v31:440-1940*v3150:9
trans9v3250=v3249/75.49791=hwz9c=*
trans9v3250=v3249/110.7491=hwz9c=*
res9sprint=*sink*
list9jim9*print*
rel9*print*
two v=7201;413,414 op=col c=v1*v414:1-10*v413:1-10
```

```
two   by   v=414,3001   st=v413    c=v72*v414:1-10*v413:1-15
op=col,tests
des by v=414 st=v72 c=v1
des by v=* st=v70 c=v1
two v=7201,72 c=v1 op=row,test
des by v=7201 st=v72 c=v1
two v=7201,3001 c=v72 op=col,test
two by v=* st=v72 op=same
two v=7201,4110 c=v72 op=col,test
two by v=7201,3001 st=v4110 c=v72 op=col,test
two v=7201;300-321 c=region op=col,test
two v=7201,423 c=v72 op=col,test
two v=4150,7201 c=v72 op=row,test
two v=2,414 c=v72 op=*

code                                                    v6392=st

st=v639:(1-10),(11-20),(21-30),(31-40),(41-50),(51-60),
(61-70),(71-76) 1=p.date

con *print* hold route=soph
res sprint=*print*
one by v=70,401-465,501-509,634-650  st=v70  c=v2:1  op=marg
head=unit 1
res sprint=*sink*
rel *print*
,1,1,1,1,1,191=parasite9c=all
code9v2001=v200191=*
code9v2002=19c=v2001:2291=morepara(no,yes)
code9v2002=29c=v2001:19-2191=*
trans9v2003=match9v=300-3109rel=11*29c=v72:291=moreworm
trans9v2003=match9v=300-3109rel=11*29c=v72:391=moreworm
trans9v2003=match9v=300-3109rel=11*29c=v72:491=moreworm
code9v2004=v20039c=v7291=moreworm
code9v2005=19c=all91=*
code9v2005=29c=v20049l=anyworm2(no,yes)
trans9v2006=match9v=313-3209rel=8*29c=v72:291=morepro
trans9v2006=match9v=313-3209rel=8*29c=v72:391=morepro
trans9v2006=match9v=313-3209rel=8*29c=v72:491=morepro
code9v2007=v20069c=v7291=morepro
code9v2008=19c=all91=*
code9v2008=29c=v20079l=anypro2(no,yes)

mount c8078a 9tp *t* ring=in vol=vija 'vija'
con *t* posn=*1*
read int new v=426,431,436,441,446,3001-3003,70,72 f=*t*
rel *t*
con *print* hold route=soph
res sprint=*print*
two by v=446;3001-3003 c=v446:2 st=region op=col,tests
two  by v=426;3001-3003 c=v426:2*v431:1*v436:1*v441:1*v446:1
st=region op=same
two v=same c=same op=same st=none
two by v=431;3001-3003  c=v431:2*v426:1*v436:1*v441:1*v446:1
```

```
st=region op=same
two v=same c=same op=same st=none
two     v=6360,4090,419,4180,4150,6400,644,645,635;3001-3003
c=all st=none op=same
one v=6360 c=v70:1*v2:1 op=marg
trans v4140=v413/v414 c=v2:1
code v4141=v4140 points=,1,2,3,4,5,6,7,8,9, c=v2:1 l=p.r.
one v=4141 op=marg c=v2:1
code v3201=cuts(v32) points=,49,2000, l=weightl
code v3102=cuts(v31) points=,100,2100, l=heightl
des v=32,31,3201,3202
des v=32,31,3201,3102  c=v3201:2+v3102:2
res sprint=*sink*
dis *print*

con *print* hold route=soph
res sprint=*print*
read                          int                          f=data*
v=70,3010,3223,7201,3001,72,4010,4090,4110,4150,4180,7201
read int f=5eu4:variable v=3111,3211,3250,8
mount c8078a 9tp *t* ring=in vol=vija 'vija'
con *t* posn=*1*
read int f=*t*
rel *t*
code v7000=v70*10000 l=*
code v7001=v7000+v71 l=family2
code v2100=st st=v21:4,5-9 l=*
code v800=v8:1-15 l=kids
compute new st=v3001 v3500=count(v7001)  c=v800 l=*
compute new st=same v3510=count(v3001)  c=same l=*
compute new st=same v3520=fraction(v3001,2) c=same l=*
compute new st=same v3530=v2100 c v7:2
set new
read int new v=72 f=data*
hist v=3500 c=v7220 int=/.05
hist v=3500 int=/.1 c=v72
two v=3530,3500 c=v72 op=col,row,tests
set data
code v3700=v7001 c=v3001:2 l=inffam
two v=7201,3001 c=v72 op=col,row,tests
rcorr v=7201,3001 c=v72 op=rho
code v4500=1 c=v72 l=highrisk(no,yes)
code v4500=2 l=highrisk(no,yes)
code v4500=2 l=highrisk(no,yes)
code v2140=1 c=v72 l=dumbhead(no,yes)
code v2140=2 c=v7:1*v21:4 l=dumbhead(no,yes)
code v2610=1 c=v72 l=nojob(no,yes)
code v2610=2 c=v7:1*v26:1 l=nojob(no,yes)
one v=2140,2610 op=marg
code v4501=1 c=v72 l=hirisk2(no,yes)
one v=4500 op=marg
one by v=4500 st=v72 op=marg
two   v=6360,4180,4090,4110,4150,446,4010,7201;3010    c=v72
op=row,col,tests
```

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ANALYSIS OF ENVIRONMENTAL DATA FROM RURAL EGYPTIAN VILLAGES

F. DeWolfe Miller, Ph.D.

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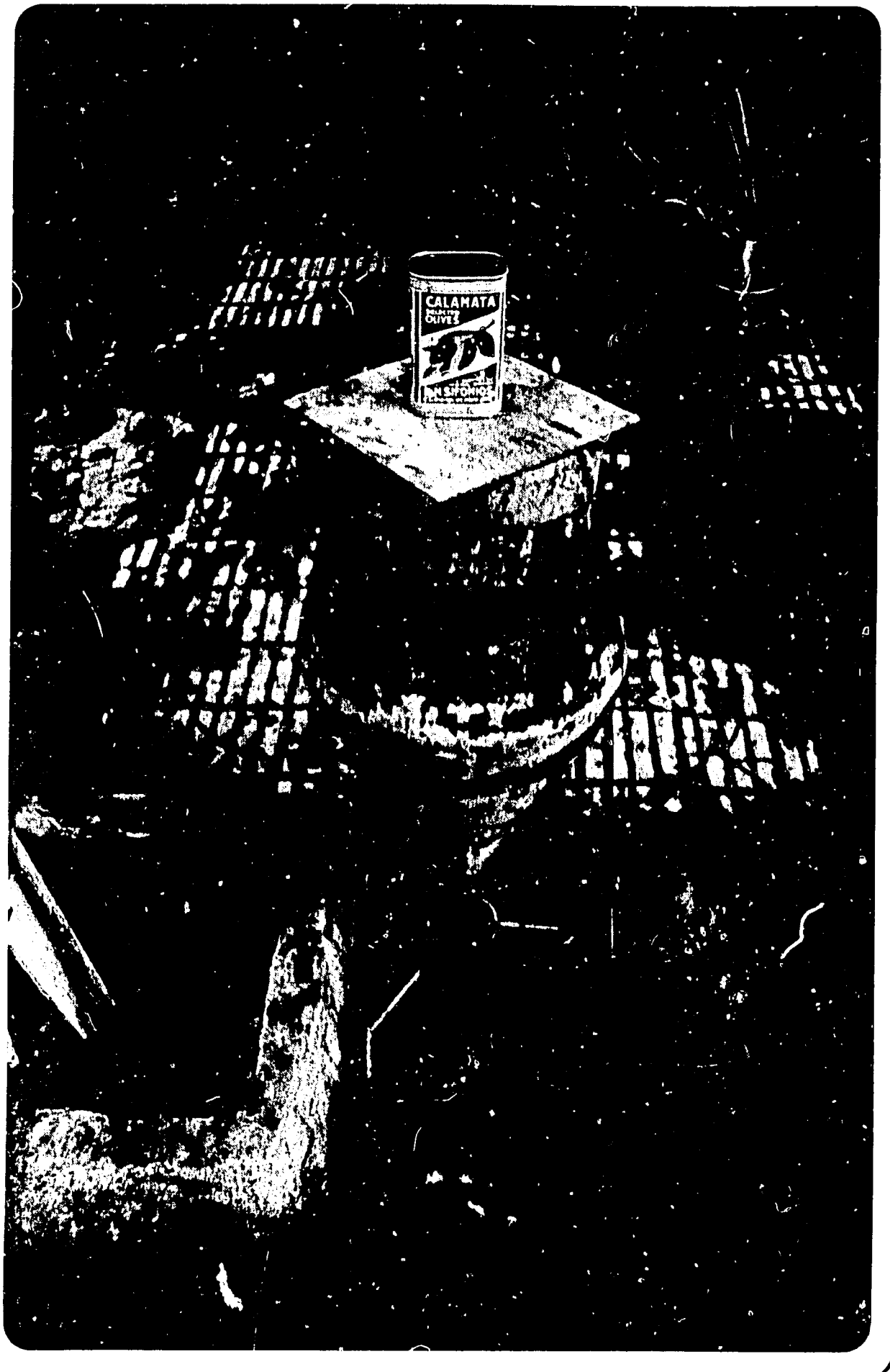
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ANALYSIS OF ENVIRONMENTAL DATA
FROM RURAL EGYPTIAN VILLAGES

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CHAPTER ONE

SUMMARY AND RECOMMENDATIONS

1.1 Summary

This report is an analysis of environmental health data collected from 35 rural villages and hamlets located in the three major geopolitical regions of rural Egypt. The broad base of the data collection provided useful information on the current status of a number of environmental health conditions.

Some form of protected water supply was available at all villages and hamlets except one. These supplies were under heavy demand by the villagers. Unprotected canal water was resorted to even in the presence of the protected supplies, especially for washing clothes and kitchen utensils and for bathing. The distribution of protected supplies indicated that some villages were in greater need than others. The Middle Egypt site at Beni Suef had the lowest service per capita of piped water supplies.

One or more zirs, the household water containers, were found in every house regardless of where water for the house was obtained. The water in the zirs is easily and probably frequently contaminated. Unless the zir can be improved or discontinued there is a strong implication that if water supplies were to be expanded to supply every home the quality of the water consumed would not be substantially improved.

Drainage of waste water was an isolated problem rather

than a uniform one. Generally, accumulation and inadequate drainage was noted more frequently in the Nile Delta site in Kafr El Sheikh.

Simple pit latrines, frequently without a cover, were very common at every study site and used by family members, especially adult women. Since 1960, a third of the latrines in the study had been installed at some point after the house had been built.

The rate at which new houses were being constructed may not be great enough to keep up with demand. A crowding index suggested that the newer homes were housing more and more people. Most houses were made of unfired mud brick or a combination of mud and fired brick. Patterns of construction appear to be changing and better materials are more frequently used in newer homes.

Demographic and socioeconomic factors of the sampled individuals are reported. These results compare favorably with the available demographic data collected by other studies.

Collectively, parasitic infection was common. However, the prevalence of infection with a specific pathogenic helminth or protozoan was unexpectedly low. The most common parasite was *Entamoeba coli*, a non-pathogenic protozoan. Over half of the sample was infected with one or more of the parasites screened for. Associations were found between the three major protozoan infections, *E. histolytica*, *G. lamblia*, and *E. coli*. *A. lumbricoides* and *S. mansoni*

infections were the only helminthic species found to occur together. The composite parasite variables, infection by any protozoan and infection by any helminth, were also related. These findings suggest that dual infections do not occur randomly.

The measures of height and weight were analyzed and described and differences noted between regions. There was a consistent lack of association between height/weight measurements and infection and the independent variables. Nor was there any difference between sexes and the infection variables. Infection frequency did increase up to the second decade of life, after which the prevalence of infection remained rather constant.

Water, excreta disposal and the other major environmental and housing variables were examined for associations with infection with each of the parasites studied. Composite and multi-parasite variables were prepared and tested. Tests were made for associations between regions, within regions and between individuals at country-wide, regional and study site levels. All tests were negative, or the direction of association was inappropriate to reject the particular working hypothesis under examination. There were two exceptions, the age of the house and the use of dung as a cooking fuel. Both were found to be related to protozoan infections. The age of houses was elaborated on in respect to other housing factors, some of which were found to strengthen the

relationship.

Family size and structure were not found to determine the pattern of infection within the family. However, if the mother was infected by a protozoan there was an increased risk that the children would also be infected.

Attempts to identify high risk homes indicated that mud houses with dirt floors and a head of household who was unemployed and illiterate were the factors most strongly associated with infection. The unemployed illiterate head of house was an important contributing variable. Individual housing characteristics were less so.

Caution must be taken when generalizing these findings to extend to other regions of rural Egypt. Unrestricted application of the results even within a region may be hazardous, especially in the Aswan area, where variation from one study site to another was considerable.

1.2 Recommendations

There are both general and specific recommendations for interventions and for further investigation.

A strong demand exists for the current water supplies and data suggest that expansion of the current piped water supply system would be readily accepted. More information is needed for placement of standpipes and what method of closure should be adopted. Standpipes should be placed so as to reduce contact with surface waters. Better methods of simple and appropriate drainage systems will have to be developed parallel with programs to increase water supplies.

Reduction of surface water contact may necessitate development of public facilities for washing and bathing. Seepage and low cost small bore wastewater collection systems should be tested in villages with different ground water levels.

There should be a tube well improvement program. Such a program should be integrated with any new drainage schemes.

A latrine improvement program based on the improved ventilated designs for pit latrines is clearly needed. Even in the presence of substantial coverage by latrines there is evidence of considerable contamination of the environiment with excreta. Therefore, programs to broaden the use of latrines or other excreta disposal systems to both sexes and all age groups is very important.

The current socio-cultural circumstance does not encourage appropriate defecation habits in the young and very young. Latrine and other excreta disposal programs are of little use in the absence of full participation by the community. Any latrine improvement program should include public facilities as well.

Alternatives and/or improvements to the household water container, the zir, must be developed if there is to be any beneficial impact by any given sanitary or hygienic intervention.

No data on food and personal hygiene was collected, and no related past data on food and hygiene was discovered for

rural Egypt. These problems must also be described and addressed before improvements in health status can be expected.

The results suggest that improved housing may not be as important as housing availability. Improving housing availability has many positive implications. Research to determine the impact of increased availability on the rural-urban migration patterns should be very worthwhile. Model rural housing projects from which useful information could be obtained are already established.

There seem to be advantages in directing village expansion to the nearby arid areas that border the narrow strip of cropped land. There were no indications that environmental health or health status as measured here was lower in villages located in these adjacent areas. Schistosome infections in inhabitants from villages built in these areas had an overall lower prevalence compared to nearby villages located within the cropped areas (Miller et al. 1978 and King et al. 1981).

It is also recommended that a routine population-based surveillance program for monitoring environmental health changes over time be designed and implemented. The results from this study indicate that a relatively small sample can be obtained that will provide adequate precision for a regional survey. Environmental monitoring is an accepted and necessary practice from which rational interventions can be identified and evaluated.

CHAPTER TWO

INTRODUCTION AND BACKGROUND

Chapter Two examines the problems of environmental health conditions in rural Egypt and specifies the need for population based data. Current theory of the relationships between typical environmental variables and health and disease are pointed out and the manner in which this theory is extrapolated to the rural Egyptian circumstance is described. Background on the field work, sample selection, and methods are set forth briefly. The programs for the management of the data base and analysis are also included in this chapter.

2.1 The Problem and the Need for Data

Over half of Egypt's population lives in the rural sector. This rural population contributes substantially to Egypt's food production and the GNP. However, the environmental setting and health status of this population, when compared to many urban sectors in Egypt, is considerably lower. Compared to environmental and health standards of other countries, these conditions would appear to be acute. Infant mortality is recorded to be very high and parasitic and other infectious diseases, particularly enteric infections, are common (NAS, 1979). These conditions are typical of and frequentely attributed to an unsanitary and unhygienic environment.

A review of the literature on environmental health conditions previous to this study was completed by Miller et

al. (1978) and Miller et al. (1980). Past findings strongly indicated that the environmental health conditions of the rural Egyptian village (in particular, sanitation and hygiene) were very poor. The past data collected and dated from 15 to 30 years previous. Individual studies never included more than a few villages at a time. The data collected was typically gathered without strict and reproducible sampling protocols. It was readily apparent from this review that current environmental data on a regional and country-wide basis, obtained by reproducible probability samples, was altogether lacking.

Given that the information available is very limited, the need for such data are twofold. One, there is a primary and urgent need for current descriptive information necessary for defining the magnitude and distribution of the environmental health problems. For example, a typical environmental improvement needed in rural developing areas is a program for excreta disposal. Before such a program can begin it is necessary to determine the nature and extent of coverage of any existing disposal systems. A second and equally important need is for the identification of specific environmental factors which are causal or which are directly related to disease. If such factors can be found, specific intervention can be planned with a quantitative expectation of the outcome in terms of health impact. These factors are further discussed in the next section (Section 2.2).

The second application for cross-sectional

environmental survey data, is that the results of the survey can be used to establish a point of comparison for which changes in time can be measured and important rates can be determined. Also, the results will provide a basis on which evaluation of interventions can be measured. This is an important feature, as strong biases can develop over whether or not an intervention has given the expected result to the expected magnitude. Baseline data provides the necessary means for a rationale evaluation.

2.2 Relationships Between Environmental Health Factors and Disease

By establishing an association between environmental health factors and disease, justification for environmental health intervention is advanced. As stated, intervention is directed with greater accuracy and efficiency, and the outcome (benefit) can be projected and quantified. The actual identification of relationships may also lead to a better and more fundamental understanding about the transmission and dynamics of the respective disease. Such insights often provide a basis for a more general application of specific control measures.

However, the study of etiological relationships, whether environmental or otherwise, do not require large sample selections from the population of interest. Indeed, when etiology is the primary study objective, it is desirable to reduce the sample size to the minimum necessary to obtain the desired level of statistical significance. To

do this is cost efficient. However, the results of an etiological study can only be made relevant to a specific region or country by obtaining survey data available on representative samples of the target population. Aspects of both survey and etiological objectives can be included in a single study. The section on data collection (2.3) describes the design of this study and how objectives for both etiologic and survey data needs were developed.

Infectious disease transmission is an interplay between the host, the environment and the infectious organisms. Superficially, the environmental factors in rural Egypt can be reduced to domestic water supply, excreta disposal, food sanitation, personal hygiene and related behavior, housing conditions, village environmental conditions, animal wastes, other solid waste, insect vectors and agricultural practices. One of the foremost epidemiological relationships to be demonstrated between environmental factors and health has been the one between water supply and water-related diseases (See Feachem et al., 1977 for a catalog of water-related and excreta-related diseases). Other approaches, primarily microbiological, have firmly established water as a vehicle or medium of transmission for a broad range of infections. However, unequivocal epidemiological evidence for the transmission of many of the enteric diseases by water in rural areas of developing countries has been very difficult to obtain. Bradley (1975), reporting to the World Bank, reviewed the data and

stated that "it is extremely difficult to identify and measure exactly the health effects of improved water supply, and there is a limit to the precision obtainable." Numerous and extensive epidemiological research efforts have been completed in many different countries with very mixed results. Briscoe (1978) found it difficult to establish an epidemiological relationship between the classical water-borne disease, cholera, and type of water supply and its use. The Guatemala experience (see Schneider et al. 1978 and Shiffman et al. 1978) is another example where considerable effort was invested to find links between water supply and disease. The results of the Guatemala study are still under review. The problems encountered in attempting to describe what appears to be a straightforward relationship between water and disease must be borne in mind when considering the analysis presented in the coming chapters. Most of the past studies referred to above were designed specifically to address an etiological relationship between health and the environment. The study design employed by this investigation was not specifically chosen to resolve this issue, but rather designed to address other related objectives (see Miller et al. 1978).

The investigation of excreta disposal and its role in the dissemination of disease has, like water-related diseases, been extensively explored (Feachem et al., 1978). The results have not always been consistent or illuminating. For example, Farooq et al. (1966) found in the Nile Delta

that schistosome infection was lowest in the group which had latrines, but did not use them. There was little difference in the prevalence of infection between the groups who had latrines that were used or did not have latrines. Like the water-related diseases, there is considerable supporting data indicating that a reduction of human fecal material in the environment via a suitable disposal mechanism would lower disease incidence and improve health. Substantial documentation reviewed by World Bank studies have failed to find epidemiological evidence that excreta disposal in rural areas, like Egypt, reduces the transmission of related diseases (Feachem et al. 1978). Feachem et al. (1978) concludes that good excreta disposal is necessary but not sufficient for the control of excreta-related diseases. Therefore, controlling these diseases cannot be expected in absence of good excreta disposal systems.

Similar conclusions are appropriate for improving water supply.

Housing and village environmental conditions most likely interact with water supply and excreta disposal in the transmission of these infections. There is little information on the role of housing factors and disease in rural Egypt, or elsewhere in the developing world (Mitwally and Shankowi, 1970; WHO Tech. Rep. Ser. 1967). More typically, studies measuring housing or village factors have been concerned with malnutrition and socio-economic relationships rather than infectious diseases (Koopman et

al. 1981). Weir et al. in 1952 considered the village housing conditions in the Nile Delta irreparable, but did not analyze the data to demonstrate relationships between housing factors and infection or disease. In this respect, the data collected for this study offers a relatively unique opportunity to examine the impact of housing and village environmental conditions on the distribution and prevalence of certain enteric parasites.

No doubt the other environmental health factors mentioned above, i.e., food sanitation, solid waste, insect vectors, etc., play a role in the dissemination of disease and most likely serve as redundant links in the chain of transmission for most of the enteric infections. In this study other objectives precluded measurement of these specific factors. These environmental factors are too numberous to be evaluated by a single study. The general lack of knowledge about these factors and their role in the etiology of enteric diseases in rural Egypt, compounds the difficulty with which conclusions can be made. The known theoretical role that these unmeasured factors play strongly suggest that any results obtained is potentially confounded.

2.3 Synopsis of Data Collection and the Data Base

A complete and detailed description of the methods used in this study are published elsewhere (Miller et al. 1978). Briefly, the data was collected on 43 villages and hamlets. These villages and hamlets were clustered into 20 study sites in which there was one or more villages. There were

four major study site areas located in four separate regions of the Egyptian Nile Valley north of the Aswan High Dam. Figure 2.3 A is a map of Egypt showing the location of these four areas. One study area was situated in the north central Nile Delta in the governorate of Kafr El Sheikh; seven villages and hamlets were selected. South of the Nile Delta in the governorate of Beni Suef, another six villages and hamlets were selected to represent the Middle Egypt Region. In the far south, 22 hamlets, comprising about eight villages, were selected. These villages were located in the Aswan governorate. Some villages were distinctly different from others. Also included in the study were villages from the Nubian resettlement area, Kom Ombo. This is called New Nubia and is within the boundaries of the Aswan governorate. Although there were eight villages and hamlets smapled the results from New Nubia are not a part of this analysis. The Nubians of Egypt are found almost entirely in New Nubia, Kom Ombo, or as isolated families in large urban areas. No other indigenous rural communities of Nubians exist in Egypt, except for a very limited population of Nubians living just south of the city of Aswan and north of the old Aswan dam. Old Nubia was inundated by Lake Nasser with the closing of the New Aswan High Dam in 1964. The Nubian population is distinctively different from the rural Egyptian population both ethnically and culturally. Furthermore, the government's Nubian resettlement plan provided the new housing in Kom Ombo necessary for the

relocation of the population. The new housing was developed on replicate plans. The architecture and material were the same from house to house, and the structure of housing in one village was identical to the next.

Because the Nubians are a uniquely different population and live in homes that are essentially identical to one another and in a defined area, the data collected from this group is excluded from the analysis. Population estimates would be relevant only to the Nubians and not to the general or even local rural Egyptian population. The similarity of housing conditions precludes a comparative analysis of housing factors and infection which further justifies the exclusion of the Nubian data from the analysis.

At each study site a sample of the population was made from a complete list of families. On the average, 800 persons were selected and examined and about 190 homes inspected at each site. The total sample of 12,059 persons (excluding the five Nubian study sites) was 18.1% of the total combined population of all 15 study sites. Table 2.3 A shows the pattern of selection and response of the sampled population. Each person, regardless of age or sex, was requested to give a stool and urine specimen which was examined for parasites (Miller et al. 1978). A complete list of the measurements taken are shown in Table 2.3 B.

Results were scored on three separate data forms: one for the family and individual, one for the results of specimen analysis, and one for the inspection of the house.

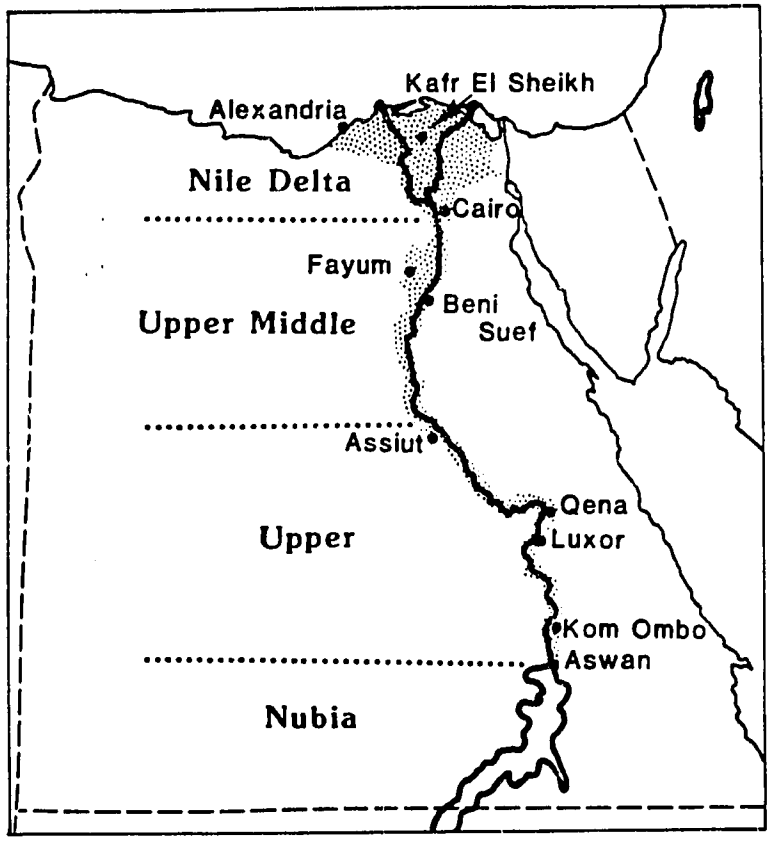


Figure 2.3 A A map of Egypt showing the location of the Study Areas.

TABLE 2.3 A The Pattern of Selection and Response

Study Area	Study Site Code	Number of Persons Examined	Number of Families Examined	Number of Persons Not Giving a Specimen	Number Selected But Not Attending	Number of Homes Examined	Population
Aswan	1	908	196	25	46	202	2371
	2	993	224	46	89	237	4021
	3	508	124	46	42	140	1915
	4	785	210	29	266	224	4701
	10	537	193	36	0	191	3076
Beni Suef	11	384	108	20	244	186	8958
	12	846	200	129	0	200	4961
	13	920	213	68	0	226	1610
	14	751	199	47	0	198	6777
	15	776	198	20	0	200	9250
Kafr El Sheikh	16	916	199	0	0	200	4135
	17	984	211	15	93	200	2937
	18	896	197	14	5	200	2031
	19	837	204	82	89	298	2700
	20	1018	218	145	0	218	7325
Total		12059	2894	722	874	3120	66768

TABLE 2.3 B List of Variables Measured

Variables
Individual Variables
Age
Sex
Relation to Head of Household
Number of Years Living in Village
Marital Status
Number of Pregnancies
Number of Live Births
Number of Still Births
Treatment for Parasitic Infection
Height
Weight
Parasitic Infection
Occupation
Education and Literacy
Swimming Habits
Housing Variables
Construction
Attachment
Painted Walls
Staircase
Roof Material
Roof Condition
Storage
Floor Construction
Number of Windows
Lighting and TV
Number of Rooms
Water Supply
Number of Persons
Stable
Stable Cleaning
Waste Container
Animal Waste Disposal
Cooking Fuel
Ownership
Storage of Water
Drainage
Excreta Disposal

Copious field notes were taken on the general environmental

conditions of each village and hamlet. The data from these three forms was coded separately and key punched. Over 40,000 punch cards were generated. Verification of all coding and punching was completed. Routine programs were written to identify inconsistencies which resulted in either a correction of the data based on the original data form or excluding the record from the analysis. About 1% of the data set was excluded because of coding or punching errors or other inconsistencies. Since response by the selected population was generally very good, the amount of error related to data collection and processing is considered reasonable and generally insufficient to warrant special treatment in the analysis.

Building the data base required that the information for each individual was combined as a single record with the information on parasite infection and housing data. The combined records were assembled one study site at a time. There were 15 different data sets which in turn were combined to provide a single file which is maintained on magnetic tape. Since there were over 15 thousand records or cases (the Nubian data was included at this stage) with over 150 variables per case considerable temporary computer memory was required and special programs had to be written to store the combined sets of data before the final data based was transcribed on tape. The programs to manage and analyze the data are part of the Michigan Interactive Data Analysis System (MIDAS). The MIDAS package allowed for the

specification of any subset or strata of the data set to be analyzed. Using MIDAS, the analysis was completed interactively. That is, program commands and results could be given and obtained immediately while remaining actively connected to the computing system (Michigan Terminal System). The implication of a given result could be acted on immediately. The analysis capabilities of MIDAS are broad and include all standard statistical techniques (see MIDAS, 1978). Listings of all program commands for data management and analysis are given in Appendix A.

CHAPTER THREE

DESCRIPTIVE RESULTS

Introduction

In this chapter the frequencies of environmental, demographic and dependent variables are tabulated and assessed. Differences in the distribution of these variables by region and village are noted and interpreted. Interpretation of the findings is based on relevant observational data taken during the field work and the results of other pertinent studies. The reader will see that both intervention and research needs are generally noted in this chapter as well. In fact, the descriptive findings of this chapter comprise an important part of environmental problem identification, magnitude and distribution among the respective study areas. These aspects of environmental problem definition are the essential elementals of planning interventions and evaluation.

3.1 Environmental Variables

The environmental variables measured in this study, as described in the previous section, were water supply, drainage of domestic waste water, excreta disposal, and housing. Also discussed in this section are the relevant demographic and individual characteristics such as sex, age, education, occupation and literacy.

3.1.1 Water Supply

It is universally accepted that an ample, safe and

protected supply of clean water is fundamental to good health. Long lasting improvement in health status cannot be expected in areas where this is lacking (Bradley, 1976). It follows that the provision of such a supply to the rural villages of Egypt is a very important environmental health advance. Therefore the results obtained from the villages studied project pertaining to the supply and source of water for domestic use are considered first.

Water for domestic use was divided into water 1) obtained for drinking, 2) for bathing, 3) for washing clothes and 4) for washing utensils. These categories were not scored in a mutually exclusive fashion. More than one source of water, i.e., piped, hand pumped or well, canal, e.g., could be scored for any given use. As expected, the results of the survey show that alternate sources of water were frequently used.

In the three study areas (Kafr El Sheikh, delta; Beni Suef, middle; Aswan, upper) an estimated 2.4% of the houses had a piped supply inside the home. All piped supplies were either from deep bore hole wells (Aswan and Beni Suef) or from a water treatment plant (Kafr El Sheikh). The ground water in the Kafr El Sheikh area was not suitable for drinking because of high mineral content. The water obtained from bore holes was not chlorinated. Water treatment plants, at the time of the study, chlorinated the finished supply, although residual chlorine may or may not have been present from the point of collection. Residual

chlorine levels were not measured. However, discussions with water treatment plant operators indicated that bleaching powder used for chlorination was not always in ready supply.

A much greater percentage of families (58%) obtained their drinking water from a public piped water supply. The different piped supplies all had a common source of water at any given study site. Water obtained from public spigots or standpipes located in the village was carried various distances to the home. The number of standpipes varied from area to area and from study site to study site. Table 3.1.1 A shows the number of standpipes by site and the number of persons/standpipe. Three study sites, one in Beni Suef and two in Aswan, did not have a piped water supply available at the time of the study. One study site in Aswan was obtaining a public standpipe just as the field visits were coming to a close. The other two sites, one in Aswan and the other in Beni Suef had alternate sources of protected drinking water supply through hand pumps. All study sites in Kafr El Sheikh had one or more standpipes with an average of 299 persons (approximately 73 families) per standpipe. Note that the mean number is the simple division of population by the number of standpipes. The actual number of persons using a standpipe in a given village was not determined. We are making the assumption that the standpipes present in a village are used by everyone. (Actually a percentage of the population have inside piped

water or use hand pumps.)

It is expected that the range of persons per standpipe within a given village would vary substantially, indicating that some standpipes are under extremely heavy demand by the village users. Damaged standpipes, observed frequently (but not recorded), suggest that these facilities undergo heavy use. Some study sites had very high ratios of persons per standpipe. Even considering the overall mean service of 444 persons per standpipe, which is very high, there would be about 107 families using a standpipe. If one family member visited the standpipe once a day to draw water, there would be 10 to 11 persons per hour for every hour of a 10 hour day at the standpipe. If each person used 20 liters per day the typical spigots would have to deliver 8,880 liters over a 10-hour period of use, or about 0.25 liter/sec. constant flow rate. An increase in flow of four times to compensate for peak demand would indicate that the pipe would have to deliver a flow of 1.0 liters/sec. The inside diameter of pipe needed would have to be at least 37 mm. Different size pipe diameters were noted. However, 37 mm. pipe is larger than that generally seen.

Assuming that a 20 liter water container (typical size) is used to collect the water from the standpipe and assuming that a liter of water is delivered every two seconds , which is reasonable for pipe sizes seen, then 40 seconds would be needed to fill the container. The total procedure, which includes placing the container at the spigot, filling it

TABLE 3.1.1 A

Distribution of Standpipes by Study Site and the Mean Number of Persons that Each Standpipe Would Serve. The Range of Persons per Standpipe is Not Known.

Region	Study Site Code (One or More Villages)	Number of Standpipes	Population	Population per Standpipe
Upper	1	0	2,371	0
	2	8	4,021	503
	3	3	1,915	638
	4	9	4,701	522
	10	0	3,076	0
Subtotal		20	10,637	532
Middle	11	0	8,958	0
	12	6	4,961	827
	13	8	1,610	201
	14	7	6,777	968
	15	13	9,250	712
Subtotal		34	22,598	665
Delta	16	20	4,135	207
	17	7	2,937	420
	18	4	2,031	508
	19	5	2,700	540
	20	28	7,325	262
Subtotal		64	19,128	299
Total		118	52,363*	444

*Study sites 1, 10, and 11 are not included in the total.

with water, removing the filled container and placing it on the head, takes approximately one to two minutes. In about 15 to 20 minutes the 10 to 11 persons (always females) would each collect 20 liters of water.

In the rural areas in countries which are similar to Egypt, where standpipes are an important water source, a minimum of 20 liters/person are used each day (Cairncross

and Feachem, 1978; White et al., 1972). To supply an Egyptian family of 4.17 (the study sample family size) with that much water would require four trips daily to obtain a sufficient supply for a family of 4.17 (the study sample average family size). Since one trip by the 10 to 11 persons will tie up the standpipe for 1/3 of an hour, and three more trips will have to be made to obtain enough water for each family member, crowding would probably occur even if those collecting water were spaced as evenly as possible over a 10 hour period. Obviously, this would never be the case as there will be peak demand periods during the day and crowding will intensify during those times. In the villages where the person/standpipe ratios are even higher, there is clearly a great difference between the quantity of water desired and the amount available. Assuming that no new standpipes have been added since the study and assuming a natural increase in population of 2.5%, there are now in Kafr El Sheikh an average of 338 persons per standpipe and 610 at the high end of the range.

It is interesting to note that a much larger percentage of the families (18.7%) draw drinking water from a canal in Kafr El Sheikh than in either of the other two regions (Table 3.1.1 B). However, none of the Kafr El Sheikh study sites was without piped water and the standpipe densities overall were better in Kafr El Sheikh than elsewhere (Aswan = 532). Furthermore, nine families who had inside connections in Kafr El Sheikh also scored the canal as a

drinking water source. Five hypotheses were developed to explain this:

1) Some Kafr El Sheikh women like to socialize at the canals.
2) Some canals are closer than the standpipes (applicable to those who do not have indoor piped water).
3) The piped water may taste bad from time to time due to chlorination.
4) The piped supply may not be continuous.
5) When standpipes are crowded, water may be more conveniently obtained from a canal which is relatively closeby.

If the piped supply either is unsuitable or is not flowing, then those that have piped inside water would not be getting water from the piped outside supplies either and this would explain why the canal was scored as a source (3 or 4). Since none of the families with piped inside supplies obtained water from piped outside supplies, we can assume that three and/or four are possible hypotheses. However, for those who obtained water from standpipes and canals, it is possible that some canals were either more convenient in relation to the position of the standpipes or there were times when the taste or odor of the piped supply was unsatisfactory (2 or 3).

Since these data show that there are families who have piped-in supplies and still draw canal water, but not water

TABLE 3.1.1 B

Source of Domestic Drinking Water.
The Percentage of Families Which Obtain
Their Water from the Respective Sources.
Classification was not Exclusive.

Source	All Study Sites	Kafr El Sheikh	Beni Suef	Aswan
Pipe Supply Inside House	2.5	4.1	1.1	2.1
Hand pumps				
Inside	7.0	<1.0	5.1	16.1
Outside	22.2	<1.0	65.6	4.9
Pipe Supply Outside	58.0	90.6	30.3	47.3
Canal	8.3	18.7	3.2	1.9

from other outside piped sources, and families who do not have piped-in supplies and obtain water from both standpipes and the canals, hypotheses 3 and 5 seem most attractive. Hypothesis 4 is weakened by the larger number of families who state that their water for drinking is obtained from piped sources and not from the canals. Nevertheless, intermittent supplies is an obvious recurring problem and is also a good explanation of why the families with indoor supplies resort to the canals.

It is proposed here that if the number of standpipes were increased in the Nile Delta, fewer persons would use the canals as an alternate drinking water supply. The standpipes are clearly popular and if placed strategically to be more accessible than the canals, available drinking

water quality would be greatly improved.

Kafr El Sheikh had the mean lowest ratio of persons per standpipe and Beni Suef the highest, 299 compared to 665 respectively. This was true in part because one study site in Beni Suef did not have any piped water, but primarily because there were simply fewer standpipes available. This demand was dampened somewhat by an alternate water supply from shallow driven tube wells (hand pumps) available to 65.6% of the families. Indoor wells were also noted in 5.0% of the sample. These wells were installed in the courtyard. In order to contain the spillage of water within the yard, these pumps were frequently surrounded by a small mud wall which diverted the flow back around an unprotected casting, most likely contaminating the well source. Such design was seen outdoors as well, but more often the outside hand pump had no wall. Spillage nevertheless had created a depressed area around the casting, resulting in essentially the same conditions seen with the wells with mud walls. Although adequately protected tube wells no doubt exist, this writer has never seen one in rural Egypt.

The well parts, pumps and skill to install these pumps are widely available in rural Egypt. Any program to improve the method of installation should include appropriate further training of the installers and provide improvement of existing tube wells as well.

Beni Suef had many more families obtaining their drinking water from hand pumps than either Kafr El Sheikh or

Aswan. This distribution is seen in Table 3.2 which also shows the pattern of drinking water supply for all three areas for the four major types of water sources - pipes in the houses, hand pumps on shallow wells, pipes to public spigots, and canals.

Both hand pumps and standpipes were present together in the Beni Suef study sites and the use of one source did not exclude the other (see Table 3.1.1 C). Sixty families (or 10%) obtained their water both from hand pumps and standpipes located outside the home. This was very common in study site number 12 where 53.6% of those who obtained their drinking water from hand pumps also visited the standpipes. We do not know why both sources were used or which was preferred. If a hand pump was inside the house the outside standpipes were not visited. The presence of outside hand pumps seemed to reduce contact with the canals. Only 5% (27 families) obtained drinking water from both outdoor hand pumps and the canal. As shown, more families obtained drinking water from the canals in Kafr El Sheikh than in Beni Suef, even though the Kafr El Sheikh sites had more standpipes per person. There were enough hand pumps to supply the 490 families (53.4%) which depend only on this source. These data strongly suggest that hand pumps can be an acceptable single source of drinking water, at least in terms of supply.

The microbial quality of the piped water is probably better than the water from the hand pumps, as these pumps

TABLE 3.1.1 C

Beni Suef Middle Egypt Water Supply for Drinking
Percent of Families

Study Site Number	Number of Stand-pipes	Persons/ Standpipe	HPI.DK[1] Yes	HPO.DK[2] Yes	HPO.DK[3] Only	HPO.DK:Yes and PO.DK:Yes		HPI.DK: Yes and PO.DK: NO[6]	PO.DK[7] Yes	PO.DK Only	PI.DK[8]
						Yes[4]	Yes[5]				
11	0	-	7.5	84.1	84.1	-	-	7.5	-	-	0.0
12	6	827	2.7	29.9	28.0	15.0	53.6	2.0	81.8	61.5	3.2
13	8	201	7.6	77.6	76.5	1.9	2.5	7.5	5.2	3.3	1.0
14	7	968	1.5	46.6	43.7	0.5	1.2	1.5	50.8	48.7	0.0
15	13	712	6.6	91.6	77.8	12.6	16.2	5.6	13.7	1.0	1.5

1. HPI.DK - Hand pump inside home for drinking water % of families.
2. HPO.DK - Handpump outside home for drinking water % of families.
3. HPO.DK only - This was the only source used for drinking water.
4. If a handpump was used for drinking water supply outside the home in some cases the standpipes were also used, expressed as a % of the total.
5. Same as above but expressed as a % of those who get water from handpumps outside the home (HPO.DK).
6. If a handpump was inside the home, drinking water was not obtained from the piped sources outside.
7. PO.DK - Pipe water outside home = standpipe.
8. PI.DK - These are families who have water piped into their homes.

are almost always contaminated by runoff of spilt water. There is no evidence here that hand pumps are used preferentially over the standpipes or vice versa. The figures seem to show that in the study sites where both piped and hand pump sources are present, both sources, but especially the piped supplies, were utilized. However, in study site number 13 the inside and outside hand pumps were used more, even though the persons per standpipe ratio was the lowest found in this study. The continuity of water supply to these standpipes may have been very bad. Unfortunately, the data to show this is not available. However, the location of new standpipes is nevertheless expected to be the most important factor in usage by the village people and additional standpipes placed between the village homes and the canals do help in reducing contact with raw surface water and the risk of schistosomiasis transmission.

In Beni Suef only a very few families have water piped into the homes (1.1%). Although study site 14 had a piped supply, none of the homes studied had indoor piped connections. This did not seem to result in increased use of canal water which was highest in study site 15, but very low throughout.

Use of canal water for drinking in Beni Suef did not appear to be associated with the presence or absence of piped or tube well supply or a combination of these types of supplies. Furthermore, canal water was never an exclusive

source of drinking and was always sighted in combination with some other source. This was true in Beni Suef and all other study sites as well. Indeed, the results indicate that improved sources for water may be used exclusively, while canals are not.

In Aswan, even fewer families stated that a canal was used to collect drinking water, and in each case piped outside supplies were also indicated. In the three study sites where water was piped to the village, 91% of the families used the supply. This and other aspects of Aswan water supply are shown in Table 3.1.1 D. Two study sites did not have a piped supply. One study site, number 10, relied heavily on hand pumps. Only at this study site was the ground water high enough for shallow driven tube wells. Unlike the other areas, these hand pumps were far more common inside the home (76.6%) than outside (22.3%).

TABLE 3.1.1 D

Aswan Upper Egypt
Water Supply for Drinking
Percentage of Families

Site Number	Piped Outside (PODK)	Piped Inside (PIDK)	Canal (Canal DK)	Nile River	Hand Pump Outside (HPO.DK)	Hand Pump Inside (HPI.DK)
1	0.0	0.0	0.0	100.0	0.0	0.0
2	92.7	4.5	3.9	0.0	1.1	1.7
3	90.5	4.8	6.7	0.0	1.9	2.9
4	90.3	2.6	0.0	6.6	0.0	0.5
10	0.0	0.0	1.1	0.0	22.3	76.6

In terms of water supply, the most unusual study site was located in Aswan (site number 1) and was the southernmost village in the study and the first village north of the outfall of the old Aswan Dam. The village was bordered on one side by a low barren ridge and on the other side by the River Nile which comprised the sole source of water for this study site. Water for all uses was dipped from the river which was located less than one kilometer to the south of the dam. There were no canals, hand pumps, or piped supplies, although the new water treatment plant in Aswan was installing standpipes at the time when data collection had just finished. The ethnic origin of the study site population was entirely Kenuz Nubian who, because of their extreme northern location, have never had to be relocated.

There was another small group of families (7%) in study site 4 which lived in a hamlet located apart from the main village cluster, a distance of about four kilometers. This hamlet, like study site number 1, had been built on the banks of the River Nile, obtained a small portion of its water from the river. Unlike study site 1, this hamlet was served also by a single standpipe.

Both the Aswan and Beni Suef study sites have their own particular pattern of use for water supply for drinking. Both were more diverse than that seen in Kafr El Sheikh. In Kafr El Sheikh, drinking water was almost entirely sought from the piped supplies with some use of the canals as an

alternate source.

The overall pattern is clear. Most villages in the study had one or more piped sources of drinking water either inside or outside the home and these supplies were in heavy demand. In areas where piped supplies were not present and suitable ground water was present, hand pump tube wells were found installed and used in a manner to suggest preference over the raw surface sources. There was a single and highly unique exception in Aswan study site number 1 where water was drawn directly from the River Nile. It is suggested here that there were very few villages like study site 1 either in Aswan or elsewhere in rural Egypt. There was no case where a village depended for drinking water solely on canals. Furthermore, drains or ponds were never indicated as a source for drinking water at any study site.

Three summary points can be made about drinking water supplies in the study villages:

1) Drinking water was obtained from either piped supply, hand pumped tube wells, the canals or the River Nile inclusively.
2) There was almost always an alternate improved (over that of raw surface water) source of water available in the study villages. It is probable that most villages have similar circumstances.
3) The alternate improved supplies, which were under great demand, were either in poor repair, incorrectly installed or operated, or broken. This

was the most likely reason that villagers were exposed to even more contaminated surface supplies.

Storage of Drinking Water: the Zir

A zir is a conical shaped (20 to 40 liters) storage vessel for drinking water made of unbaked porous pottery which slowly "sweats" its contents. The evaporation of the water slowly dripping over the sides cools the water inside. The manufacture of the zir does not include any type of cover but there may or may not be a cover fashioned of scrap tin or wood, or other improvised m terial. The conical shape of the zir requires a special stand that ideally suspends the zir allowing the water to drip down the sides freely, collect and drip off the pointed bottom. This, of course, creates a small, more or less permanent pool of standing water under the zir that may be contained or left to run off freely. To get a drink, water is dipped out of the zir with whatever is handy, usually a tin can. The can is grasped by the rim and dipped into the water. Sometimes a person will have to put his whole arm inside the zir to fill the can. Drinking water is not collected from the water that seeps through the zir walls.

In some villages people, when asked, claimed to wash the zirs out twice a week. Soap was not used for cleaning the zir, as it would be difficult to remove the soap from the porous walls. In other villages the zirs were rarely, if ever, cleaned, as evident by the confluent growth of algae that develops on the sides of the zir when left

undisturbed.

More than 95% of the village homes surveyed had one or more zirs. Some households had several zirs with a total capacity of as much as 60 liters each. These larger zirs are primarily storage vessels. The smaller, 20 liter zir serves as the drinking water supply. The smaller one will cool water down quicker and maintain a slightly lower temperature, due to increased surface area for evaporation per unit volume. The resident time of water in a zir will differ according to the size of the vessel, but is clearly limited to three days at a maximum and a matter of hours at a minimum.

It is interesting to note that zirs were present in all the homes studied which had inside piped water supplies. Limited observation at these homes indicated that the zirs present were in use and filled from the tap inside the home on a regular basis. This suggests that the drinking water quality in homes with piped water is probably very similar to that of those where the water is obtained from a standpipe, as in both cases the water passes through the zir to the consumer. More observational data is needed to confirm this pattern of water storage and use. Unless the zir can be improved (or discontinued) there is strong implication that if water supplies were expanded to every home the quality of the water consumed would not be substantially improved.

The use of this traditional water vessel and its

ubiquity would seem to establish the zir as the focal point in the ecology of water-related and oral-fecal borne diseases throughout rural Egypt.

Because of the uniform distribution of the zirs, analysis of the zir and parasitic infection is circumvented. In order to find associations there must be a suitable group of individuals in the sample who do not have zirs or do not use them. This does not seem to be the case in rural Egypt. Therefore, one of the most important comparisons that could be made in this analysis cannot be examined. There is clearly an important need for research on the microbial dynamics of water stored in the household zir.

Field observations revealed two basic types of containers used to fetch and carry water. One, the traditional oula, is a ceramic or earthenware jar of 15 to 20 liters. It has a round pear-shaped bottom and a narrow neck. The safiha is a locally made galvanized bucket with two handles, has a capacity of 22 liters and costs roughly the same as the oula. The safiha is an open bucket with cylindrical sides and is much easier to maintain and clean than the oula. There are also several smaller water vessels, most of which are used for storage or transport. The kola is a one liter water jug of porous earthenware used to cool drinking water. It is also pear-shaped in design and has a lid built into the neck of the jar. The lid, which has several holes approximately 5 mm in size, prevents water from flowing freely or spilling out of the jug when

tipped. It also prevents the jug from being thoroughly rinsed out. The kola may be filled directly from a tap, the zir, or other container. The kolas in the house are shared by all family members except infants. Data is also needed on the microbial contamination of these water containers.

Water supply for other domestic use

Water supply for bathing, laundry and washing utensils was obtained from the same sources as drinking water. No other sources were noted. The pattern for all study sites together for any three of these activities was different than the pattern for drinking water, however. In other words, if families obtained their drinking water from a standpipe, as the majority did, they did not necessarily use standpipe supplies for the three other uses.

In Kafr El Sheikh, where 18.7% obtained drinking water from the canal, 61.8% to 64.4% used canal water for bathing, washing clothes or washing household utensils. Significant variation of this pattern was noted among the study sites. At the Aswan sites little use was made of canals. The few present were not easily accessible. In study site 10, which was topographically very different from the others, canals intersected the village. Apparently the common and readily available hand pumps in this area, especially the large percentage of indoor hand pumps, was sufficient to supply the needed water for the other domestic uses. Overall, the vast majority obtained their drinking water from a protected supply, whereas 31% of the families used canal water for

laundry, 24% for bathing and 29.6% for washing utensils.

This study did not determine where this water was used. It could have been drawn from the canal and used in the home, or washing activities could have been performed at the canal. Although it seems unlikely that the canal water would be drawn and carried to the home, especially when the respective activities are commonly seen by the casual observer in the village setting, one might argue that the canal water was drawn because of crowding and long waits at the standpipes. Moreover, the water quality for these activities would not be as important as that desired for drinking or cooking. Either way the piped supplies are obviously not an exclusive source for all uses of domestic water as these data show.

The question to be answered is, "Would an increase in water quantity and availability reduce the percentage use of the canals for washing activities?" Although the evidence is not unequivocal there are impressions which stem from the experience of collecting the data from the field and analyzing it. The fundamental one is that increases in quantity and availability of the type of protected supplies that already exist in rural Egypt would be a significant environmental health improvement and perhaps the most significant overall health improvement possible. Furthermore, the data presented suggest that protected supplies are popular and will be used except in extreme cases (example: installation of a standpipe where run-off

from the pipe would have resulted in undesirable water accumulation in a cemetery). The popularity of protected water should have a direct effect on reducing the percentage of families using hazardous raw surface water for domestic purposes.

3.1.2 Drainage of Domestic Wastewater

Water brought into the village home is either consumed or used and discarded as wastewater. Over 90% of the discarded water is disposed of directly in village streets adjacent to the home or at a convenient spot where other households dispose of their wastewater as well. Where the latter occurs, the percolation and drainage of the wastewater into the subsoil is frequently too slow to clear before more wastewater is added. The accumulation of discarded wastewater quickly forms septic pools causing a significant sanitary problem in the villages. This condition is often exacerbated by poor drainage at standpipes or hand pumps. As water quantity is increased wastewater drainage problems are expected to worsen in these rural areas. Homes with large families or with inside piped supplies will discharge greater amounts of wastewater. Just how these greater volumes are managed and what impact they have on the overall village drainage problems remain to be determined.

3.1.3 Excreta Disposal

Latrines were commonly found in the homes surveyed throughout the study sites. Overall, 74% of the homes

sampled had latrines. Other studies (Weir, 1952; Farooq, et al., 1966) confirm that latrines are common, and programs for latrine construction in Egypt date back to the 1920's. The frequency of latrines was markedly different in the three different regions with Kafr El Sheikh having the most (91 percent), Beni Suef the least (43 percent) and Aswan about in the middle (79 percent, See Table 3.1.3 A).

TABLE 3.1.3 A

Percentage of Homes by Latrine and Region

Region	Latrine		No Latrine
	Used	Not Used	
Kafr El Sheikh	88.0	3.2	8.8
Beni Suef	43.1	1.6	55.3
Aswan	77.4	1.9	20.7

Although a latrine is present in the home it may or may not be used. Just over two percent of those who had latrines stated that they were not used. Non-use was distributed relatively evenly in the different study areas. In study sites numbered one (in Aswan) and nineteen (in Kafr El Sheikh) non-use was quite high, 19 percent and 15 percent respectively.

It is not known why a latrine is not used. Furthermore, if a latrine was stated as used it does not mean that all family members use the latrine all the time. Limited information from villagers indicate that the latrine

was built for the adult females in the family. The purpose of the latrine was to provide privacy. It was not determined whether or not sanitation was also desired. Clearly, younger children are the principal sources of the frequently noted excreta seen in village streets throughout the study sites. This observation is an old one that was first made by Headlee (1937) when there were fewer latrines. Apparently, the installation of latrines has not eliminated this type of contamination. Whether or not it has reduced it, we do not know.

When covers were present they were found on latrines that were used (99.5%). The hypothesis that covers were present because the pit was full and therefore, not used, is rejected. Nevertheless, the most likely explanation that a latrine is not used is that it is full. The date for the construction of the latrine was recorded in addition to the date that the house was constructed.

Since 1960 a third of the latrines in the study had dates of construction that were more recent than the home construction dates. However, the great majority of the latrines present were installed when the home was erected. The data show that latrines were being added to homes with various dates of construction rather continually down through the past several decades. There is a hint that more latrines were being added during the more recent decades than before, but the trend is neither strong nor clear. Likewise, it would appear that more and more houses were

built with a latrine as part of the design. Even so, three decades ago, about 60 percent of the homes built included a latrine in the construction of the house.

The following figure (3.1.3 A) is a histogram of dates of latrine construction. For example, there were 238 latrines with dates between 1967 and 1971. The histogram shows a steady increase in the net number of latrines being constructed. Note that the 1976 period shows the results of only the number of latrines built for the years 1974, 1975, and 1976 (1976 is the last midpoint). If the latrines were continually added at this three-year rate (118/3 = 49.3 latrines/yr.), then 197 latrines would be completed for the entire period which falls just short of the previous 1969 to 1973 period, which was 238.

Latrines were rarely simple boreholes. Most often simple pits were dug. Over a third of these were lined with stone or rock. This pattern of construction did not change much over several decades.

Obviously, latrines are not an unknown to the rural Egyptians. To the contrary, they are commonly found and appear to be popular. When homes are built without them, latrines are frequently added later.

3.1.4 Housing

Date of Construction

Results from the histogram given below (Figure 3.1.4 A) show the number of homes grouped into five-year periods

FIGURE 3.1.3 A

Histogram of Latrine Dates for All Study Sites

Midpoint	Count	Each X=10 Latrines
1901	85	XXXXXXXXX
1906	38	XXXX
1911	36	XXXX
1916	40	XXXX
1921	40	XXXX
1926	35	XXXX
1931	57	XXXXXX
1936	43	XXXX
1941	75	XXXXXXXX
1946	89	XXXXXXXXX
1951	158	XXXXXXXXXXXXXXXX
1956	133	XXXXXXXXXXXXX
1961	228	XXXXXXXXXXXXXXXXXXXXXXX
1966	235	XXXXXXXXXXXXXXXXXXXXXXXX
1971	272	XXXXXXXXXXXXXXXXXXXXXXXXXXX
1976	136	XXXXXXXXXXXXXX

according to the date given for the construction of the house. During the period from 1968 to 1973 (midpoint year ≐ 1971), there were on the average, about 50 homes added per year (246/5 = 49). These 50 homes make up about 2.1% of the cumulative sample of this period. A continuous 2.0% average yearly increase in homes was estimated from 1951 through 1976. There was a substantial gain in the number of new homes built during this period as reflected in the histogram. (Although it is not possible to tell from these data the number of homes that are destroyed or demolished, there is little indication that this happens. Furthermore, it cannot be determined what if any renovation of older homes has been completed.)

FIGURE 3.1.4 A

Histogram of House Dates for All Study Sites

Midpoint	Count	Each X=10 Houses
1901	122	XXXXXXXXXXXX
1906	99	XXXXXXXXXX
1911	112	XXXXXXXXXXX
1916	95	XXXXXXXXXX
1921	179	XXXXXXXXXXXXXXXXXX
1926	143	XXXXXXXXXXXXXX
1931	131	XXXXXXXXXXXXX
1936	90	XXXXXXXXX
1941	143	XXXXXXXXXXXXXX
1946	161	XXXXXXXXXXXXXXXX
1951	199	XXXXXXXXXXXXXXXXXXXX
1956	155	XXXXXXXXXXXXXXXX
1961	255	XXXXXXXXXXXXXXXXXXXXXXXXX
1966	192	XXXXXXXXXXXXXXXXXXX
1971	246	XXXXXXXXXXXXXXXXXXXXXXXXX
1976	74	XXXXXXX

For the midpoint year of 1976, the histogram includes only the period from 1974 to 1978. Obviously, data are not available for 1977 or 1978. Seventy-four houses were built in the three-year period recorded (1974, 1975, and 1976), or 25 houses per year. An estimate of 125 houses would be built over the full five-year period assuming no change in the rate of construction. This is a drop from an average of 2.0% increase during the previous years to 1.1% for the 1974 to 1976 period. This decline in the rate of construction may be temporary. Rural building rates seem to lag behind the overall natural rate of increase of the population. The 1976 census (CAPMAS, 1976) reports that the overall increase in the rural population between 1966 and 1976 was 2.31% per

year. In the previous six-year period the rate was higher (2.54%).

If demand for housing is increasing faster than new homes are being built, then the total number of persons in a house (in answer to question, "How many persons are living in this house?") should be greater in homes which have a more recent date of construction. To test this, a multi-variant one-way analysis of variance (ANOVA) of the number of persons per house (variable #414) by date of house construction (variable #7201) was done. A very significant difference ($P<0.0000$) was found indicating that the mean number of persons in a house for a given date of construction was associated. More importantly, a distinct trend was evident. The more recently the house was built, the greater the number of persons living in the house.

The following table shows this trend.

TABLE 3.1.4 A

Date of Construction	Number of houses	Mean Number of persons per house
1901-1910	289	4.0934
1911-1920	274	4.1898
1921-1930	259	4.4788
1931-1940	186	4.6183
1941-1950	290	4.8759
1951-1960	341	4.9736
1961-1970	401	5.1796
1971-1976	176	5.1805
Total	2216	4.7144

Note that the mean number of persons living in homes dated from 1901 to 1910 was 4.0934. The mean number increases to 5.1705 by the 1971-1976 period. The overall mean was 4.7144. An increase in the number of persons per house might be compensated for by providing bigger houses or houses with more rooms. Whereas a measure for house size is not available, a house with more rooms is very suggestive of a larger house. Therefore, the same analysis was done to see if the number of rooms per house was also increasing. The results did not show a trend. The mean number of rooms per house remained relatively stable with an overall mean of 3.8 rooms per house.

Finally, the mean number of persons per room was assessed. The results from this analysis confirm that there are more people per house and per room in the newer homes. Since the mean number of rooms per house remained relatively constant, the number of persons/house increased. There was a consistent and significant ($P < .0035$) increase in the mean number of persons per room from 1.3 to 1.9 as the date of construction became more recent.

The conclusion that the rural population is outstripping its ability to provide more and bigger houses is a very reasonable one and substantiated by the data. The analysis does not include the potential effect of outward migration of the village population, however. The proportion of the population classified as rural is much smaller now (51% of the total population. CAPMAS, 1976)

than for example in 1935 when almost 75% of the population lived in villages. Just how much outward migration has affected the increase in this index of crowding is not known. Outward migration may have depressed the rate of increase in persons/house. However, it would be useful to know if rural-urban migration is in turn affected by the rural housing supply. If housing supply is affecting demographic patterns, then what are the constraints that affect housing construction rate? Is skilled manpower limited or is it the lack of materials, or land or perhaps a combination of these factors?

It is difficult to establish just how critical the housing situation is in the study site villages. It is even more difficult to assess housing limitations in terms of overall village environmental priorities. The fundamental impression is that the increasing need for more shelter is so great that other aspects such as construction design and building material or for that matter planning other environmental improvements, tend to become secondary considerations. Every effort should be made to determine what the limitations to rural housing growth are and how low cost options can alleviate them. At this point, it is not even known how or if the villager perceives this problem. It is suggested that the low cost housing project in El Hekkr, Ismailia (Technical Assistance Program, P.O. Box 114, Telex 54178 ISM, UN, Ismailia) may be a good model on which to draw and for which some of the questions for housing may

be resolved.

Construction Characteristics (Associations between housing variables)

The typical village house is made of unfired mud brick or a combination of mud and fired or baked brick (red brick). Less than 10% of the homes were fired brick. These data are shown in Table 3.1.4 A. This table shows distributional features of concrete floors, lighting, and stable location as well. There were distinctive patterns of construction between the villages. Fired brick homes ranged from less than a percent (study site 4 in Aswan) to 25.6% in Kafr El Sheikh (Study Site 16). Mud brick construction predominated throughout, however.

Fired brick was more frequently used to build newer homes, increasing from 4.3% in the oldest homes to 23.2% in the newest ones. Mud brick has proportionally declined over the same period (85.4% to 54.7%).

Typically, the house had an earth floor (67.8%) but like fired brick, concrete floors were becoming increasingly more common in the newer homes as earth floors were proportionally becoming fewer. The percentage of concrete floors increased steadily from 7% in the oldest homes to 35.3% in the newest. Furthermore, concrete floors were twice as common in fired brick homes as mud ones or mud and brick combination (M/B homes); 43%, 22.8%, and 11.2% respectively. These differences were very significant, $P < .0000$. Lighting with electricity was more common in fired

brick homes as well, 40.8% as compared to 21.6%, but even more common in the M/B home (48.9%). Otherwise, the M/B home was generally the poorest in terms of floor type, stable location and attachment. The M/B house had more earth floors (88.8%), more often had the stable inside, and was typically attached on three sides to other homes. Table 3.1.4 B shows these different aspects of building construction. Surprisingly, ownership, i.e., whether the house was rented or owned, was not associated with type of construction material. Latrines were associated with type of construction and again it was the M/B home which had the lowest frequency (66%). Latrines were not a great deal more common in mud homes (71%). Fired brick homes, however, almost always had a latrine (90%). Finally, the mud and M/B homes used dung as a source of cooking fuel more often than the fired brick homes. The distribution between fired brick, mud, and M/B was about 12%, 14%, and 24%. These different aspects are shown in Table 3.1.4 C.

3.1.5 Village Aspects

Within a region or a study area, the villages selected were generally typical of the locale. In Kafr El Sheikh and Beni Suef, all the villages studied were surrounded on all sides by perennially irrigated lands. In some cases, irrigation canals cut through the village. The primary activity in these villages was agriculture. (Farming and related job classifications were consistently indicated by the male head of house throughout the villages in Kafr El

TABLE 3.1.4 B

Percentage Distribution of Housing Characteristics by Region

Characteristic	Study Site or Region -Percentage of Homes in-			
	Kafr El Sheikh	Beni Suef	Aswan	Overall
Fired Brick	15.4	5.7	6.7	9.5
Mud	77.7	69.6	80.6	76.1
Mud and Brick	5.7	22.8	5.5	11.1
Concrete Floors	51.0	0.8	6.0	20.1
Electric Lighting	17.7	23.4	39.5	26.4
Stable Outside	4.2	10.2	15.0	9.6

TABLE 3.1.4 C

Percentage of Homes by Construction with Given Characteristic

Characteristic	Type of House			Statistical Significance
	Fired Brick	Mud Brick	Mud and Fired Brick	
Concrete Floors	43.0	22.8	11.2	P<0.0
Electric Lighting	40.8	21.6	48.9	P<0.0
Stable Outside	12.7	9.8	8.5	P<0.0
Attached on 3 Sides	18.0	29.5	37.8	P<0.0
Home is Rented	87.6	90.6	90.9	P=.48
Latrine Present (Used)	90.0	70.6	65.6	P<0.0
Dung Used as Cooking Fuel	11.6	13.8	23.9	P=<0.0

Sheikh and Beni Suef.) Rice and cotton were more commonly cultivated in Kafr El Sheikh. Aside from the type of crop, the intensity and practice of agriculture between the two regions was very similar. There was no cultivation within the boundaries of these villages or any other of the villages in the study and the village housing, markets, schools, mosques, etc. were grouped tightly together and intersected only by very narrow, unpaved streets. Typically, there were two or more dirt roads leading to a village. Aside from agriculture, the most fundamental difference between the villages in Kafr El Sheikh and Beni Suef was simply population size (see Table 3.1.1 A). All villages, throughout the entire study were within five kilometers or less of a rural health unit or rural health center.

The villages studied in the Aswan region were in several respects quite different from each other and from the villages in Kafr El Sheikh and Beni Suef. The southernmost village studied was located south of the city of Aswan. This village, called Kakhor, is the southernmost village in the Egyptian Nile Valley, just north of the low old Aswan Dam. The village lies just a few hundred meters north of the old dam. It is comprised of Nubians of the Kanoose tribe, and it should be pointed out that Kakhor and a few remaining villages just to the north, are also populated by Nubians who because of their location downstream from the Aswan High Dam construction site, did

not have to be moved when Lake Nasser began to fill. Rather, this small population of Nubians are living in the same villages and the same homes that they were living in before the High Dam was built, or for that matter, from the last century and before. There was no irrigation of crops in this village, nor were there any nearby irrigation canals. The village was bounded on the west side by the Nile and on the east by a low barren ridge. Frequently, income was remitted by male family members who worked and lived in larger urban areas in the north. A low male:female ratio in the village reflected this characteristic. As mentioned previously, this village had no protected water supply and obtained water from the Nile River. (It is possible that some of the drinking water was carted in from Aswan.) The classification of occupation by the responding male head of the household (MHH) in this village was unique. Fifteen and three-tenths percent of the MHH were cooks, door men, or domestic servants of some type in Aswan. This village accounted for 64% of all those responding as such from the entire study population. Seventy-five percent of the MHH either had a skill or were laborers other than farmworkers. None of the MHH reported being employed in agriculture-related occupations.

The villages located between Aswan and the Kom Ombo plain (see map, Figure 2.3 A) were communities typical of the area. All were located on the eastern bank of the Nile. These communities were characteristically found in high,

dry, barren ground. Because the Nile valley is so narrow in this area, very little land was available for cultivation. Therefore, what was available was far too valuable to build on. The cultivated areas were always found as a green strip between the village and the river, with the exception of Hagar, a very small village in Ga'afra, which was located on a low barren hill next to the river. In this respect, these villages were unlike the ones in the Kom Ombo agricultural plain or Kakhor. From the northern point of the Kom Ombo plain, continuing north, the narrow valley gradually begins to widen as it passes through the next two governorates, Quena and Sohag. Villages were found within the cropped area with increasing frequency as one travels north and east of Kom Ombo into Quena and Sohag. Farther north, only a small fraction of the rural population resided in villages located outside the cultivated land, and these villages were often bounded on one side by their fields.

The health center at Bimban (study site number 10), was selected to represent villages typically built within the cultivated area of Kom Ombo. Six different villages all located in Bimban markaz (center) were sampled. The Bimban markaz was located on the western bank of the Nile Valley, almost directly west of Daraw. The Bimban area is essentially an isolated area as it is surrounded on all sides, except the east by desert. There are no roads, other than animal tracks that lead out of Bimban to the north or south. To travel out of Bimban and Kom Ombo one must first

cross the Nile at Daraw by sail boat (falucca). The villages of Bimban were separated from the Nile and from the desert to the west by fields of sugar cane and wheat, and by palm groves, etc.

Again, employment classification shows important differences between the villages north of Aswan and those in Bimban. In the villages in study site 2, 95% of the employed MHH reported that their jobs were unrelated to agriculture and were predominantly of the skill type (92%). This village was within 3 to 4 km of Aswan City. Clearly, this population, although village type in physical structure and appearance, was not agrarian. The two other study sites (numbers 3 and 4) that were also south of Kom Ombo, have men doing agricultural work, 30 and 18 percent respectively. Substantial numbers of MHH were skilled, however. Compared to the villages in Bimban, where 70% of the MHH were farmers and the remaining unemployed, these villages, in study sites 3 and 4, were mixed as to their agrarian characteristics.

In conclusion, the villages of Kafr El Sheikh, Beni Suef and Bimban were relatively similar, apart from specific water supply and housing aspects. The other villages in the Aswan group were quite different, both in respect to cultivated land and the employment of the respective village population.

3.1.6 Demographic and Socio-economic Measures

Age and Sex

Individuals participating in the study were classified

into 15 age groups. Each age group covered a five-year period except for the first which comprised the infants less than one year of age, and the last which combined all those persons 65 years or older. Fig. 3.3 A shows the age distribution of the sample which is typical of populations in developing countries.

Age distribution differences between study sites in a given region were too small to be statistically significant. Age distributions between regions did differ significantly but the differences were very small. Furthermore, the age distributions for each region corresponded well with census data specific for the rural area of the governorate from which the sample was taken. Sex ratio (male/female) did not vary significantly between study sites in any given region, but they were significantly different among the three study areas. The reader is referred to Miller et al. (1978) for a more detailed description of these results.

Occupation

Every individual in the study was assigned to one of 14 occupation classes. Most of the individuals were unemployed, which included all those under 10 years of age (27%). Forty-two percent of the unemployed were females, although a third of this group stated that they were housewives. Fourteen percent of the males, 15 years or older, were unemployed at the time of the study of which 11% were 60 years of age or older. In essence, 13% of the potential labor force was without work. Unemployment of

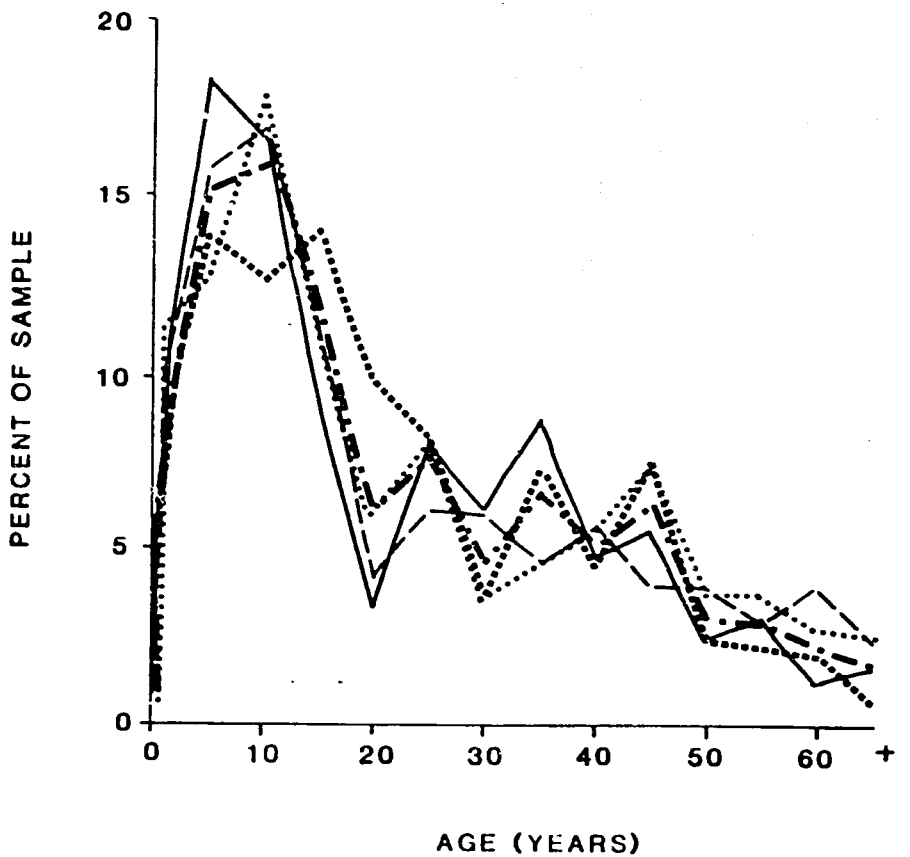


Figure 3.3 A Age Distribution of Sample for Aswan

(MHH) was much lower. Overall only 3.9% of the MHH were without a job. The regional distribution of MHH jobless was very distinctive however, with Aswan having twice the number of MHH jobs as Kafr El Sheikh or Beni Suef.

The largest class of employed men (48%) were farmers. No other specific type of employment dominated the remaining responses. Rather, the several different types of occupations cited were evenly distributed. Some type of skill was claimed by 13% of the employed men.

Most women classified themselves either as housewives or unemployed. However, some females participated in the labor force and 8.6% of those 15 years or older were classified by region. Ninety-four percent were found to live in Kafr El Sheikh, five in Beni Suef and less than two in Aswan.

The schistosomiasis study that was completed parallel to this survey (see Miller et al. 1978) showed that more females were infected with schistosomes in Kafr El Sheikh than in Beni Suef or Aswan. More specifically, the difference between the prevalence of schistosomiasis in males and females was not as great in Kafr El Sheikh as in the other two study areas. The greatest difference in schistosomiasis prevalence between males and females was found in Aswan. The differential involvement of females in agriculture, more in the north than in the south, has been a commonly held explanation of why proportionally more females are found infected in Kafr El Sheikh than in the other areas

of the south. These findings support this hypothesis.

Education and Literacy

Each family in the study was interviewed for educational and literacy status. No direct measures of knowledge or skill were taken. Of the males 10 years of age or older, 13% claimed an ability to read, write, or to have completed a primary or secondary education. Less than 1% had attended a post-secondary institution. A larger proportion of the men (19%) claimed an ability to read but not write. Thirty-nine percent of the male population, 10 years of age or older, were illiterate. Almost twice as many women (74%) in this same age range (10 years plus) were illiterate. A very low percentage of the women (9%) could read and only 6% could both read and write.

School attendance was higher for 5 to 19 year old males than for females (42%). Fifty-three percent of the eligible population of both males and females attend school. A shortage of schools may explain this low attendance figure. However, a proportion of the non-attendance was attributed to the fact that 22% of the males between nine and 20 years old were recorded as working instead of going to school. The following table (Table 3.1.6 A) shows these features.

Statistically significant differences between the three study areas were found for literacy status. Seventy percent of the individuals living in Kafr El Sheikh were classified as literate (able to read and write or to have completed a primary or secondary education) whereas only 9% of Beni

TABLE 3.1.6 A

Education and Literacy Status for Males and Females 10 Years of Age and Older

Sex	Illiterate	Some Education*	Read Only	School Attendance
Males	39%	13%	19%	64%
Females	74%	6%	9%	42%

*Read and write or have completed a primary or secondary education.

Suef's population and 11% of those in Aswan fit into this category.

3.2 Overall Frequencies of Dependent Variables

A dependent variable is one which is expected to be influenced by another variable, typically called an independent variable. Generally, an independent variable can cause qualitative or quantitative changes in a dependent variable. By definition the reverse is not true. An example of a dependent variable is a parasitic infection in a population, the prevalence of which is found to be affected by age (an independent variable).

Two types of dependent variables were measured in this study: the presence of one or more parasitic infections, and height and weight. The distribution of parasitic infections will be discussed first.

3.2.1 Parasitic Infection

The following is a list of parasites which were

included in this study.

The test results were scored positive if a parasite was present in the stool, and negative if it was not.

These parasites can be broken down into two groups: the helminths and the protozoans. Each parasite by itself constitutes a dependent variable. In addition, three composite variables were constructed: one for the helminths, one for the protozoans, and one which included infections from either group, i.e., the individual would be recorded positive if any one of these parasites was detected.

A variable for multiparasitic infection was also assembled. The multiparasitic variable took on a value depending on how many different parasites were found; for example, if an individual was infected with three different parasites then the value of the variable would be three. Variables specific for multi-helminthic or multi-protozoic infection were created as well.

The overall percent positive for each parasite in all study sites combined is given in the next table.

Protozoic infections were much more prevalent than helminthic infections. The two most important protozoic pathogens, Giardia lamblia and Entamoeba histolytica, were found in 6.8% and 5.4% of the sample respectively. Entamoeba coli was the parasite most commonly found in the study, prevalent in 40% of those examined. This protozoan is not a pathogen, but is common in populations where

LIST 1

Parasite	Common name	Transmission
Helminths		
Ascaris lumbricoides	roundworm	man/pig-soil-man
Trichuris trichuris	whipworm	man-soil-man
Enterobius vermicularis	pinworm	man-man
Ancylostoma duodenale	hookworm	man-soil-man
Strongyloides stercoralis	threadworm	man-soil-man
Taenia spp	tapeworms	man-cattle/pig-man
Trichostrongylus spp		man-soil-man
Hymenolepis nana	dwarf tapeworm	man/rodent-man
Heterophyes heterophyes		man-snail-fish-man
Fasciola hepatica	liver fluke	man/sheep-snail-man
Fasciola gigantica	liver fluke	man/sheep-snail-man
Protozoans		
Giardia lamblia	intestinal flagellate	man-man
Entamoeba histolytica	intestinal amoeba	man-man
Entamoeba coli	intestinal amoeba	man-man
Entamoeba hartmanni	intestinal amoeba	man-man
Iodamoeba butschlii	intestinal amoeba	man-man
Chilomastix mesnili	intestinal flagellate	man-man
Trichomonas hominis	genital flagellate	man-man
Dientamoeba fragilis	intestinal amoeba	man-man
Endolimax nana	intestinal amoeba	man-man

TABLE 3.2.1 A

Percent Positive for Parasites
in All Study Sites

Infection	Parasite	Percent Positive
Helminth	*Ascaris lumbricoides*	4.8
	Trichuris trichuris	.2
	Enterobius vermicularis	1.4
	Ancylostoma duodenale	1.7
	Strongyloides stercoralis	.4
	*Taenia spp**	.1
	*Trichostrongylus spp**	.5
	Hymenolepis nana	3.0
	Heterophyes heterophyes	.4
	Fasciola hepatica	.1
	Fasciola gigantica	.1
Protozoans	*Giardia lamblia*	6.8
	Entamoeba histolytica	5.4
	Entamoeba coli	39.9
	Entamoeba hartmanni	1.3
	Iodamoeba butschlii	1.0
	Chilomastix mesnili	.3
	Endolimax nana	.3

*The ova of this genus is not morphologically differentiable

sanitation and hygiene are defective.

All the protozoans, as well as the helminth, *A. lumbricoides*, are transmitted via the fecal-oral route. Therefore, the presence of these parasites in the study population indicates fecal contamination of the environment. Although the other helminthic parasites studied have more complex life cycles, and therefore more complex transmission routes, all are related to inadequate sanitation and hygiene. For this reason the composite variables indicating the presence of any parasitic infection or any helminthic or

protozoic infection, were assembled. Just over 50% of the population under study was infected by at least one of the parasites. Most, (45%) were protozoic infections and 12% were helminthic.

Infections by more than one species of parasite were less common. Frequency decreased as the number of different species present increased. There were very few individuals who hosted more than four different parasites. Thirteen and two-tenths percent were infected with two parasites, 3.2% with three and 0.7% with four. The percentage of those infected with two or more parasites was 17.2%.

It should be noted that the figures given are point estimates of parasite prevalence in the population from which the sample was drawn. These estimates are overall crude proportions that change when different strata of the sample are examined. Sampling fraction varied between study sites and the point prevalence estimates were not adjusted for this variance. A weighted estimate would correctly adjust the effect of different sampling fractions. Whether to use a weighted estimate was determined by estimating the percent error attributable to sampling fraction in the crude prevalence, and assessing the error with respect to the additional computing routines that would be necessary to correct it. The calculated error was considered to be too small (<1.5%) to have a meaningful effect on the interpretation of the results, and therefore it was decided that adjustment by weighting was unnecessary.

Table 3.2.1 B shows the prevalence distributions of selected parasites. Parasites with a prevalence of less than 2% were not included. As can be seen, G. lamblia is three times more prevalent in Aswan than in Beni Suef. The percentage of those infected with exactly two parasites or three parasites was highest in Aswan.

TABLE 3.2.1 B

Distribution of Selected Parasites
Percent Prevalence

Parasite	Kafr El Sheikh	Beni Suef	Aswan
A. lumbricoides	8.3	2.1	3.2
A. duodenale	1.5	3.3	0.5
H. nana	2.3	1.0	5.5
G. lamblia	6.1	3.5	10.5
E. histolytica	4.3	5.8	6.2
E. coli	38.1	44.8	37.8
any parasite	51.3	52.1	49.7
any protozoan	43.3	48.0	49.3
any helminth	14.4	9.4	11.1
two parasites	14.4	10.1	18.2
three parasites	3.7	2.0	4.2

Other studies (Miller et al. 1980) have suggested that Upper Egypt was less infected with these parasites than the Delta region. This has certainly been found to be true in the past for schistosome infections. The distribution of the other parasites in this study does not conform to this pattern, particularly when any specific parasitic infection is considered. The prevalence of infection with any parasite is the same for each of the three areas, with roughly half of the sample infected in each region.

In conclusion, the variation in parasitic infection distribution is not sufficient to indicate that interventions or further surveillance should be concentrated in one region as opposed to another.

Regardless of the actual prevalence of the parasites studied, this conclusion is not likely to be changed, since by study design, error in detecting parasite presence was evenly distributed across all study sites.

3.2.2 Height and Weight

A value for height and for weight was obtained for each individual in the study. Height was measured to the nearest centimeter and weight to the nearest half kilogram. Generally, height and weight measurements are made for the purpose of establishing the nutritional status of a population. For such studies, only young children and infants are generally sampled. Special care must be taken for the determination of age which is usually measured in months rather than years lived. Age in this study was recorded only for the number of years lived. Furthermore, it is essential that the reader understands that this study was not designed to measure nutrition or to make any assessments of nutritional status. Furthermore, an analysis of the data from this study necessary for nutritional comparisons is not provided here.

The distribution of weight for height for all those age one to fifteen in terms of Z scores is given below in Table 3.2.2 A. (The Z score is a measure of deviation from the

overall mean. A Z score of two is two standard deviations from the mean.) The Z scores were divided into 11 groups. The interval of each group is equal to 0.99 standard deviations. Height for age and weight for age are also shown.

TABLE 3.2.2 A

Z Scores for All Study Sites

Z Score	Height		Weight		Height by Weight	
	%	Number	%	Number	%	Number
5.0+	.1	5	.4	19	.0	2
4.0	.8	37	1.1	50	.5	23
3.0	2.1	96	1.8	86	1.3	61
2.0	3.3	155	2.6	122	5.4	252
1.0	14.7	688	8.4	392	15.0	702
0.0	52.6	2460	63.4	2955	47.4	2214
-1.0	22.7	1060	21.1	981	27.0	1258
-2.0	3.1	145	1.0	47	3.0	140
-3.0	.5	24	0.0	.2	.3	13
-4.0	.1	4	0.0	0	.0	1
-5.0+	0.0	0	0.0	0	.0	0

This classification of individuals is not indicative of any particular health status or condition, but rather can provide a standard to which comparisons of individuals with particular characteristics or individuals who live in different villages or housing conditions can be made. Analysis of variance on the height and weight measures and relevant individual or environmental variables is presented in the next chapter.

The percentage of those with Z scores of -3.0 or

greater by region are shown in the next Table 3.2.2 B.

TABLE 3.2.2 B

Percentage With Z Scores
of -3.0 or Greater by Region

Region	Percentage		
	Height	Weight	Height Weight
Kafr El Sheikh	0.5	0.0	0.1
Beni Suef	0.6	0.0	0.6
Aswan	0.7	0.1	0.1

Although there were individuals in Aswan which were lower on the three respective measures compared to the other two regions, overall means of Z scores in Aswan were positive. Table 3.2.2 C shows the results of an analysis of variance (ANOVA) for the three measures by the three regions.

TABLE 3.2.2 C

Region	Mean Z Score		
	Height	Weight	H/W
Kafr El Sheikh	-0.079	0.060	0.250
Beni Suef	-0.042	-0.970	-0.190
Aswan	0.203	0.030	-0.216
Significance	P<0.0	P<0.0	P<0.0

The differences were very significant between regions

for all three measurements. Note that for height, Aswan was, on the average, taller. The variance of this mean was greater than the other two regions. Overall weight and H/W was lower in Aswan than the other two regions, indicating that the one- to fifteen-year olds studied in Aswan are taller and leaner than their northern counterparts. When all three measurements are considered, the children of Kafr El Sheikh were the shortest but comparatively weightier. The group in Beni Suef was both short and lean. When villages of Beni Suef were examined individually, significant differences for all three measures were noted. Although there were no differences greater than a half of a Z score, study site 15 was consistently the lowest. (Height Z = -.30, weight = -.35, and H/W = -.35)

There were significant differences between the sexes for height and weight, but not for H/W. Again, the actual Z scores difference was small (less than .2). Large sample size contributed to the significant findings. Even so, females were significantly taller than males (.04 compared to -0.5) and heavier (.09 compared to -.084).

CHAPTER FOUR

PATTERNS OF ASSOCIATION BETWEEN DEPENDENT AND INDEPENDENT VARIABLES

Introduction

In this chapter, relationships between the different study variables were tested for. Associations between the various dependent variables were examined first (section 4.1). Associations between dependent variables indicated special groups of individuals who had either unique host responses and/or were uniquely exposed to some environmental or behavioral factor.

An analysis of independent and dependent variables was completed (section 4.2). Relationships were tested for between individual dependent and independent variables at different levels, i.e., country-wide, regional, village, family and individual. Three levels are emphasized: regional differences, associations between villages and associations between individuals in the villages. A composite variable for infection, which included all those persons infected by any one parasite, was used for screening tests for association with the various independent variables. In this section, independent variables were subgrouped into major classes and the results of the respective analysis and interpretation were given.

4.1 Associations Between the Different Dependent Variables.

4.1.1 Associations Between Parasites.

If an individual is infected by one of the parasites studied, is this individual more susceptible to other

infections? Evidence that the prevalence of a given parasite is not distributed randomly between infected persons and persons also infected with some other parasite suggest that the host responses in the multi-infected individuals are different. Alternatively (or additionally), parasitic infections which are found associated, may be the result of an environmental exposure unique to the multi-infected group. In a previous study by Miller (to be published 1980), infection with two species of human schistosomes in the Kafr El Sheikh study population were found to occur more frequently than would be expected if the two species were distribut d randomly. Since two species of schistosome occur only in the Nile Delta, the relevance of this association is limited to the Kafr El Sheikh study sites. An environmental explanation of this association was not sought for, however, in the previous study. The analysis between dependent and independent variables in the following section (4.2) includes an assessment of the association between dual schistosome infection and environmental variables.

Tests for association were performed between all other combinations of the parasites identified by the study. A multiple rank correlation procedure was used to make a preliminary screening. Any two parasites that were significantly associated, or even marginally associated ($P > 0.1$) were then examined by a chi square test and Fisher's exact test.

A. lumbricoides and S. mansoni infections were the only other helminthic species found to be associated. Weak association was found between Entamoeba coli and both schistosome infections; otherwise there were no significant findings between the protozoans and helminths. Entamoeba coli, E. histolytica, and Giardia lamblia were all significantly associated. The strongest association was between G. lamblia and E. histolytica. There was a 2.4 relative risk of infection by both species as compared to infection with either just one or the other. There was also an association between infection by any protozoan and infection by any helminth. The relative risk of this association was 1.7.

The relationships observed for the protozoans, E. histolytica, E. coli, and G. lamblia were expected. This reflects the biological similarity of these parasites and their related methods of transmission. All three are transmitted from person to person via the fecal-oral route by infectious cysts. None had any latency periods necessary for development in the environment, nor were any intermediate hosts required. Water is a probable transport media for all three organisms.

Table 4.1.1 A shows the significant associations and their respective relative risk. The following example will help in understanding the table format. A certain number of persons were infected with S. mansoni. Dividing this group of infected into those not infected by S. haematobium

(16.1%) and those also infected by S. haematobium (26.1%) reveals that the distribution of S. mansoni infection is not even. There is an associated risk (1.62), when infected by one schistosome, of infection by the other. The association between Entamoeba coli and the schistosomes was the weakest (although highly significant). The association between infection by any protozoan and any helminth, although weak, indicates that there are host and/or environmental factors that predispose these persons to dual infections.

4.1.2 Association Between Height, Weight and Infection.

A student T test for mean Z scores between infected and non-infected individuals was done. Z scores for height and weight by age and for height for weight were used. Infection with any parasite, any protozoan and any helminth, was not found significantly associated for the case where the mean Z score of the infected group for any of the height-weight measures was lower than the non-infected group. When significance was found the mean Z scores were reversed, i.e., indicated that the infected group was heavier, taller or had a higher Z score for height by weight than the non-infected group. This was true only for a few cases and the absolute difference between the two mean Z scores was always less than one third of a Z score. Otherwise no significant differences were found.

Similar non-significant results were obtained for infection with A. lumbricoides, H. nana, both schistosome species, G. lamblia, Entamoeba coli and E. histolytica. An

TABLE 4.1.1 A

Patterns of Association Between Parasitic Infections
All Associations Were Significant, P<0.01.

Parasite All Positive for*	Percentage Associated Parasitic		Relative Risk
	Neg.	Pos.	
S. mansoni with *S. haematobium*	16.1	26.1	1.62
E. histolytica with *G. lamblia*	4.9	11.7	2.39
E. coli with *G. lamblia*	38.6	57.4	1.50
E. coli with *E. histolytica*	38.1	71.3	1.87
E. coli with *S. haematobium*	39.3	42.0	1.07
E. coli with *S. mansoni*	40.4	46.0	1.14
A. lumbricoides with *S. mansoni*	4.9	7.6	1.55
Any Protozoan with any Helminth	7.6	13.0	1.71

*Of those positive for the given parasite a percentage were negative for the associated parasite and a percentage positive. These percentages would be equal if the two parasites were randomly distributed.

ANOVA analysis was used to test the hypothesis that there were no differences between the mean Z scores for the height-weight measures and infection with one parasite, two parasites, etc., up to six parasites. Again, the hypothesis

was not rejected as no significant differences between mean Z scores and number of parasitic infections were seen.

The most reasonable explanation that a consistent lack of association between height-weight measures and infection was found is that: 1) only infection was measured. Worm burdens and other qualitative measures of infection intensity were not made. Nor was disease measured. 2) Entamoeba coli is not a pathogen and it was not expected that an association would be found for this organism. 3) The most sensitive period of growth and development, the first five years, was not measured by months but rather by years. Even when special efforts have been made by other studies to relate height-weight to infection by the most pathogenic of these infections, S. mansoni, results have been very mixed (Miller et al. 1980). In this respect these findings were not unexpected.

4.2 Associations Between Dependent and Independent Variables

Numerous associations between dependent and independent variables were tested for and are reviewed below. The general working hypothesis to direct this analysis is that certain environmental variables increase the risk of infection by one or more of the parasites studied. If consistent and strong associations were detected, this would improve the focus of intervention, provide additional justification for the cost of intervention, and establish a basis for evaluation of the direct impact on health.

Throughout this analysis, the composite variables for

parasitic infection, i.e., infection with any parasite, any protozoan, and any helminth, were employed as indicators for associations between infection and environmental variables. Since the protozoan infections were associated with each other as well as any protozoan infection with any helminth infection, the use of these composite variables as a method to screen for associations was considered relatively sensitive. That is, associations of any reasonable strength, but specific for a particular parasitic, would be detected using these variables. Further analysis using specific parasites would in turn show a strengthening in the respective relationship for the appropriate parasite.

4.2.1 Age, Sex, and Infection

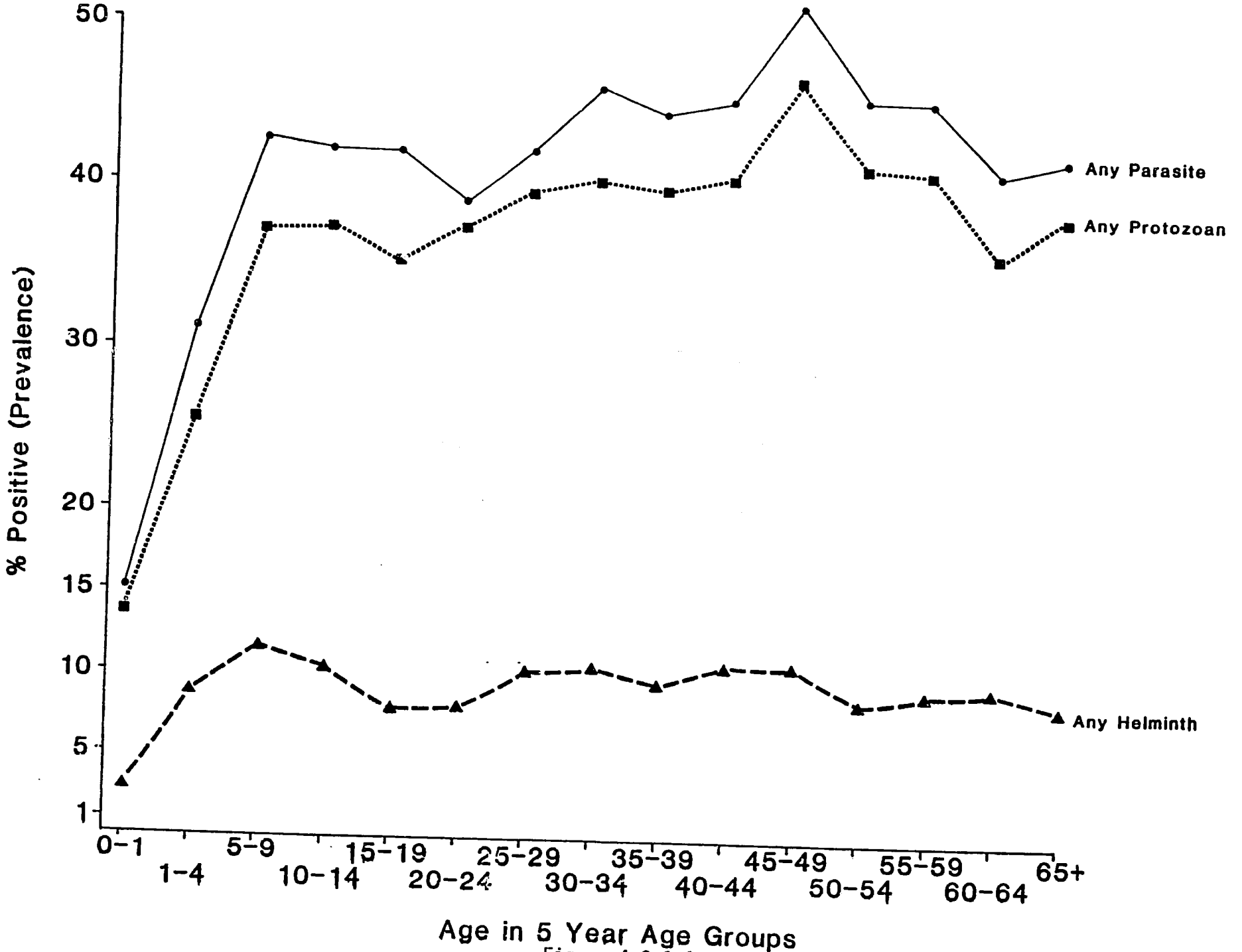
It is well known that the schistosome infections are strongly associated with age and sex. This relationship has been reported from many places of the world where schistosomes are transmitted as well as in Egypt (Farooq et al. 1966, Miller et al. 1978). Chi square tests were used to determine if there were significant distributions between sex and age.

In this study, infection other than the schistosomes was evenly distributed between males and females regardless of the parasite variable tested. This lack of association was found also for multi-parasitic infections. Females were found to be as frequently infected with two or more parasites as males. When the analysis was specified by region, the results were the same. Although the occurrence

of infection was higher in one region as compared to another, distribution between the sexes was consistently similar. For example, A. lumbricoides was two times more common in Kafr El Sheikh than Aswan. However, in all three regions, the prevalence of this infection was not significantly different between males and females.

There were significant differences between age and prevalence. Age by five-year age groups, which included all ages, and age by one-year age groups, including ages one to 15, were studied. All three composite variables for infection were significantly distributed. Figure 4.2.1 A shows the graphic distribution for parasitic infections found to be significantly distributed by five-year age groups (note that the first age group included those up to one year of age and the last age group included all those from 65 years and over). Figure 4.2.1 B was the same as the previous figure except that age was given in one-year intervals from one to 15 years of age. In addition, G. lamblia and E. histolytica infections are included. In Fig. 4.2.1 B, considerable variation is apparent, especially from age seven to 15 for E. histolytica. In part, this variation is attributed to the smaller numbers in each of the age classifications.

Typically, there is a short quick rise from the first age group that levels off in later childhood with some variation. When age by year is tabulated, the rise from one-year old generally continues throughout the next four


50
40
30
20
15
10
5
1
% Positive (Prevalence)
Any Parasite
Any Protozoan
Any Helminth
0-1
1-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65+
Age in 5 Year Age Groups
Figure 4.3.1 A

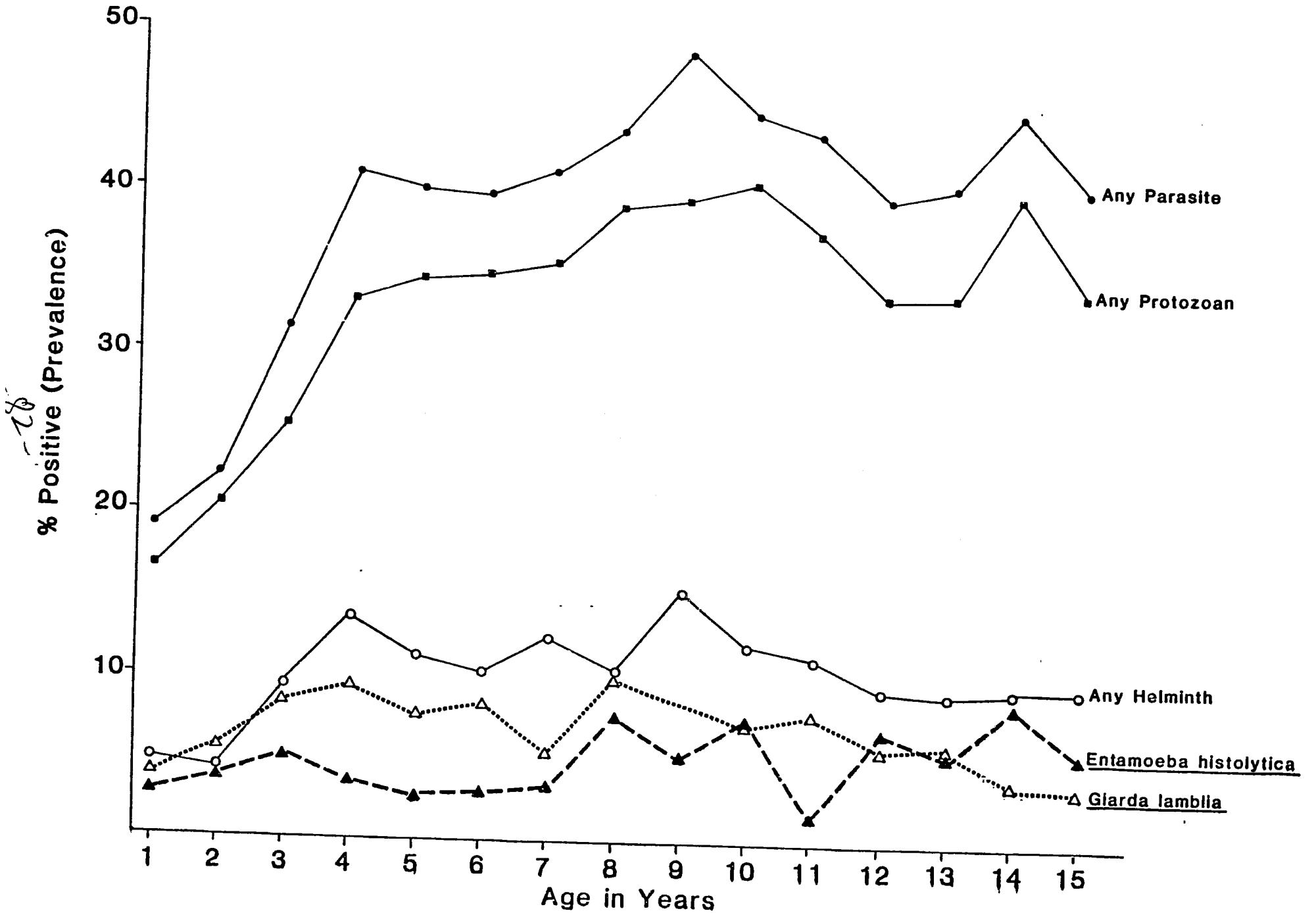

50
40
30
20
10
% Positive (Prevalence)
Any Parasite
Any Protozoan
Any Helminth
Entamoeba histolytica
Giarda lamblia
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Age in Years

Figure 4.3.1 B

years before leveling off. The curves from both figures confirm this pattern. In Fig. 4.2.1 A, leveling begins in the five to nine-year age group. In Figure 4.2.1 B, this same feature is seen to occur in the fifth year of life. There also appears to be a gentle decline in the very older age groups. A. lumbricoides does not fit into this pattern and is more evenly distributed across all age groups. Unlike the schistosomes, none of the individual infections demonstrated dramatic changes or trends with age.

Infection with any two parasites and any three parasites increased with age through the 10- to 14-year age group. A similar increase was noted for both types of multi-infection by one-year age classification, but variance increased substantially after the seventh and eighth years.

The age distribution of parasitic infection seen in these latter two figures was relatively unchanged when examined by each region. The important observation here is that any group or population strata which has a disproportionately larger number of very young persons would be expected to have an overall lower prevalence of infection. Any comparisons to other population groups should take the age structure into consideration before making any conclusions.

Water Supply and Infection

This is a particularly interesting section. One of the most challenging epidemiological problems in developing countries has been to quantitatively and causally relate

improvements in domestic water supply with improvements in some measure of health status. The theory is well established. All of the fecal-oral transmitted parasites and the schistosomes surveyed in this study can be transmitted by fecally contaminated water (for the schistosomes this route is indirect via snail vectors). Indeed, water often prolongs the parasite's cyst or ova's persistence in the environment outside the host and thereby enhances the probability that the parasite will be transmitted.

Recently, the World Bank has given extensive support to studies on the transmission of the parasites detected in this research and on other water-related diseases. The reader is referred to their comprehensive reviews of the subject (see World Bank publications on water supply and excreta disposal, 1981). As already pointed out epidemiological associations between water-related parasitic infection and water supply are not well established, with the exception of the schistosome infections. In the studies by Miller et al. (1978) in Egypt and by Jordan et al. (1975) in St. Lucia, domestic water supply improvements were found to be related to decreases in schistosome prevalence. Because of the significance of these findings, the results from Egypt (Miller et al., 1978) are reproduced here.

Tables 4.2.2 A through C show the distribution of the percent prevalence by the type of water supply used in the home. The results were consistent for both species of

schistosome in Kafr El Sheikh, and for S. haematobium in Beni Suef. In all cases as the quality of the water supply deteriorated the prevalence of the respective schistosome species increased. It was hypothesized that the improved water supplies reduced transmission indirectly by reducing water contact with infested canals. It is unlikely in Egypt that significant numbers of schistosomes are acquired orally.

TABLE 4.2.2 A

The Percent Prevalence of S. haematobium by Source and Use of Water Supply from Kafr El Sheikh Study Area.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	13.3	13.3	13.3	13.3	0.0
Piped outside	19.2	20.0	18.2	18.0	16.7
Canal	33.3	32.8	34.6	34.6	32.9

TABLE 4.2.2 B

The Percent Prevalence of S. mansoni by Source and Use of Water Supply in the Sample from Kafr El Sheikh.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	6.7	6.7	6.7	6.7	NC*
Piped outside	12.3	12.8	11.9	11.7	NC
Canal	24.7	21.4	22.1	22.0	21.2

*No Data