To the Graduate Council:

I am submitting herewith a dissertation written by Paula Merrell Butler entitled "Environmental, Socio-Cultural, and Health Factors Associated with Diarrhea in Santa Cruz Mixtepec, Juxtlahuaca, Oaxaca, Mexico." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Mary Ann Bass

Mary Ann Bass, Major Professor

We have read this dissertation and recommend its acceptance:

Edward R. Buckner

Jane R. Savage

William M. Bass

Accepted for the Council:

C W Minkel

Vice Provost
and Dean of The Graduate School

ENVIRONMENTAL, SOCIO-CULTURAL, AND HEALTH FACTORS ASSOCIATED WITH DIARRHEA IN SANTA CRUZ MIXTEPEC, JUXTLAHUACA, OAXACA, MEXICO

A Dissertation

Presented for the

Doctor of Philosophy

Degree

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ABSTRACT

This study explored the role of the environment, socio-cultural beliefs and practices, and health status indicators as factors causing diarrhea in the village of Santa Cruz Mixtepec, Juxtlahuaca, Oaxaca, Mexico. Several research techniques (microbiological, anthropometric, interview, and observational) were utilized to document the possible interrelationships of these factors. The total sample (n=177) consisted of individuals who frequented the small health clinic in the village.

Microbiological analyses indicated that every tested vector (food, feces, water and soil) contained agents that could cause diarrhea. The traditional clay water vessel was found through its shape to reduce the surface area exposed to contamination. An environmental model which accounted for 16% of the total variation in diarrheal incidence included factors such as the number of rooms in the home, total number of animals owned by the participant's family, and the presence or absence of Entamoeba histolytica in the participant's fecal specimen.

None of the socio-cultural practices (hand-washing and food preparers' practices) were found to be associated with diarrheal incidence. The lack of association may have been due to the inability to quantify these practices. The villagers' delineation of types of diarrhea closely parallels that of modern medicine.

The health status of children (n=103) was assessed by comparison to NCHS growth curves and other Amerindian anthropometric studies. Although height stunting has occurred in approximately 50% of the children, all of these children are well within the 95th and 5th centile limits. Few individuals in this village are severely or even moderately malnourished. A health status indicator model which attempted to predict diarrheal incidence included factors such as height, head circumference, and total number of tortillas prepared in the household and accounted for ~12% of total variance in diarrheal incidence.

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CHAPTER I

INTRODUCTION

Despite the tremendous advances in medicine and technology over the last decades, diarrhea or gastroenteritis remains largely responsible for the high death rates in infancy and childhood in many poorer countries and communities. In one Latin American study which examined the cause of 33,826 infant and childhood deaths, 14,513 were due to infection, while 10,037 of the fatalities or 30% were attributed to diarrhea (Puffer and Serrano 1973). In Mexico during 1974 infective and parasitic diseases which includes gastroenteritis and diarrheal disease accounted for 18.40% of the country's deaths; while 11.73% were caused by gastroenteritis and diarrhea (World Health Organization 1983).

Although the actual causative diarrheal agent may belong to one of three types--bacterial, parasitic, and viral--(Krugman and Katz 1981), factors such as environment, socio-cultural beliefs and practices, and health status are related to the development of diarrhea. Thus, the most effective method of preventing and controlling diarrhea is to maintain a sanitary environment and to use hygienic socio-cultural practices, which should foster optimal health status.

In the village of Santa Cruz Mixtepec, Juxtlahuaca Oaxaca, Mexico, diarrhea is the most common medical complaint of persons frequenting the small health clinic that served as the center for this study. Since the dynamics of the diarrheal problem in Santa Cruz Mixtepec were not clear, research was needed to isolate the factors which contributed to the development of diarrhea prior to the formation of a diarrheal control program. Consequently, the objective of this research was to explore and evaluate the interrelationship among the environment, socio-cultural practices, and health status as factors causing diarrhea in the villagers. The information generated on parasitic and bacterial infestation, physical growth, and socio-cultural practices and beliefs served as a basis for a culturally-relevant diarrheal control program in this village.

The aim of this research was to assess the incidence of diarrhea through examination of stool specimens, medical records, presence of diarrheal causative agents and their effect on the growth of children. The schematic drawing (Figure 1) demonstrates the hypothesized interrelationship between the various factors that influence the occurrence of diarrhea.

The general hypotheses were:

1. Diarrheal episodes (total number of reported diarrheal episodes) are more frequent during the wet season (May to November) than in the dry season (November to May).

2. There is no significant difference in the participant's environmental factors (number of rooms in the home, number of persons who reside in the home, number and type of animals owned, number of trips made to gather wood per month, number of hours the fire burns in the morning or evening, primary source for obtaining water

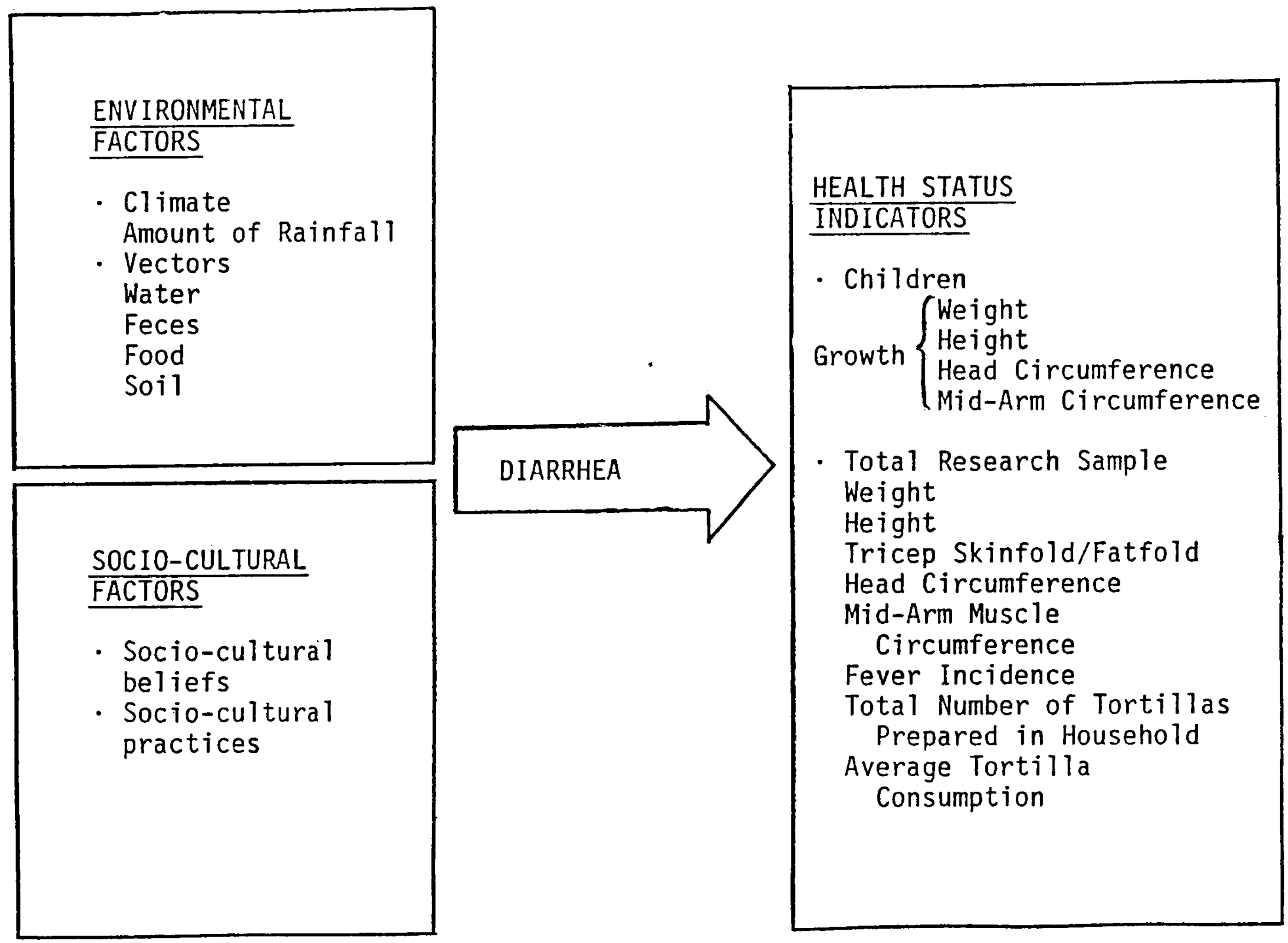


Figure 1. Schematic drawing of the interrelationships between diarrheal factors and agents.

(faucet, spring, or river), and whether parasitic agents are present in the participant's stool) and their incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

3. There is no significant difference in whether or not participants wash their hands and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

4. There is no significant difference in health status indicators of children (weight and height attainment, weight for height, upper-arm circumference, tricep skinfold/fatfold, and mid-arm muscle circumference) and diarrheal incidence (total number of diarrhea episodes/years since first reported diarrheal episode).

CHAPTER II

DIARRHEA

Scope of Problem

Obtaining reliable figures or estimations of incidence of diarrhea is difficult due to the absence of adequate recording and reporting mechanisms. The systems of recording and reporting differ considerably from time to time and from area to area, rendering a meaningful analysis almost impossible (World Health Organization 1984a). Estimations by the Diarrheal Disease Control Programme of the World Health Organization were approximately 1,000 million cases of acute diarrhea occurred in 1980 in children under five years of age in the developing countries (excluding the People's Republic of China). About five million of these cases of acute diarrhea died (World Health Organization 1983).

Despite problems associated with obtaining statistics on diarrheal deaths, reliable data for 1976 were available from the Pan American Health Organization (1980). A striking difference was noted between rates in North America and Tropical America (Mexico, Central America, the Caribbean, and Tropical South America) (Table 1). In Tropical America, diarrhea accounted for 15 to 23% of all infant deaths, and for 15 to 26% of deaths in preschool children. Diarrhea was the leading cause of death in at least five countries and the second leading cause in another ten countries.

Table 1. Comparison of diarrheal disease mortality in the Americas.*

Region	Age up to 1 Year Rate	Age up to 1 Year Percent	Ages 1-4 Years Rate	Ages 1-4 Years Percent
North	19	1.4	0.6	0.9
Caribbean	439	15.2	28.0	15.0
Central	1,078	22.8	154.0	25.8
South, tropical	1,066	20.3	151.0	21.5
South, temperate	496	10.9	20.0	9.1

*Rates per 100,000 and proportionate mortality adapted from Pan American Health Organization 1980.

Causative Diarrheal Agents

Infectious (acute) diarrhea involving the three types of causative diarrheal agents (bacterial, viral, and parasitic) may arise by either of two basic mechanisms:

1. Toxin production characterized by watery diarrhea, which is rarely associated with fever, tenesmus, bloody stools, or the findings of leukocytes in the stool. Examples of possible causative diarrheal agents of this type of diarrhea are *Escherichia coli*, *Vibrio cholera*, *Giardia lamblia*, and Viruses.

2. Mucosal invasion characterized by fever, tenesmus, and scant bloody stools containing leukocytes. Agents causing this type of diarrhea are *Shigella*, invasive *Escherichia coli*, and Amebiasis (leukocytes are rare in amebiasis).

The clinical features of diarrheal disease are noted in Table 2. Direct stool examination requires less than ten minutes' time and has been recognized and reiterated by studies (Wolff 1969; Harris et al. 1972; Pierce et al. 1974; Korzeniowski et al. 1979; Stoll et al. 1983) for its value in differentiating shigellosis and parasitic infections.

Bacterial Agents

Table 3 depicts the geographical distribution of bacterial pathogens causing diarrhea by the age group which is mainly affected. Four of the six (*Escherichia coli*, *Salmonellae*, *Shigella*, and *Clostridium perfringens*) have global distribution and two of these (*Escherichia coli* and *Shigella*) have greater incidence in children.

The percentage of pathogenic bacteria cultured from the stools of children (most less than two years of age) with acute diarrhea has varied from 4 to 33% over the last twenty years (Cramblett et al. 1971; Grady and Keunsch 1971) with the most common organism being enteropathogenic *Escherichia coli* (EPEC), *Salmonella* and *Shigella*. In a study to determine the percentage of each of the enteropathogenic bacterial agents associated with acute diarrhea, Agarwal et al. (1981) examined 127 infants and children (0 to 2 years old) with acute diarrhea, and 24 age-matched controls. The pathogens isolated and their frequency in cases of acute diarrhea were *Escherichia coli* 60.65%, *Shigella* 14.9%, *Salmonella* 15.7%, and several other mixed species 10.2%.

Table 2. Clinical features of diarrheal disease.*

Feature	Toxigenic (Small Bowel Diarrhea)	Invasive (Large Bowel Diarrhea)
Fever	Rare	Common
Pain	Midabdomen-periumbilical	Lower abdomen and rectum
Stool volume	Large, watery	Small, with mucus
Blood in stool	Very rare	Common
Leukocytes in stool	Very rare	Very common
Procteosigmoidoscopy	Normal	Edema, erythema, friability, superficial ulcers
Pathogens	*Vibrio cholera*, *E. coli* (toxigenic) Viruses, *Giardia lamblia*	*Shigella* species *E. coli* (invasive), Amebiasis

*Adapted from Edberg and Berger 1983:148.

Table 3. Distribution of established bacterial pathogens in man and the age group mainly affected.*

Bacterial Species	Distribution	Age Group Mainly Affected
Escherichia coli	Global	0-5 years
Salmonellae	Global	All
Shigella	Global	0-8 years
Vibrio cholerae	Asia and Contiguous Area	All
Vibrio parahemolyticus	Japan	Adults
Clostridium perfringens	Global	All
Staphylococci	Industrialized Nations	All

*Adapted from Harries 1976:4.

Viral Agents

Viral causes of human gastroenteritis were not recognized until a decade ago. The techniques of Electron Microscopy (EM) enabled the identification of a variety of morphologically distinct agents detected in the feces of patients with non-bacterial gastroenteritis (Lam 1982).

Human rotavirus. At present, human rotavirus (HRV) is the most extensively studied of all gastro-viruses and is clearly the major viral cause of gastroenteritis in children (Lam 1982). HRV has at least two antigenic types which do not appear to be confined to distinct geographical locations. Yolken and his colleagues (1978), in a study in Washington, D.C., found that the majority of participants developed antibodies to two distinct types of HRV (HRV-1 and HRV-2) early in life. Infection with HRV-1 was associated with high rates of asymptomatic cases, whereas all HRV-2 infection exhibited symptoms of gastroenteritis.

Norwalk and Norwalk-like agents. A serological study by Greenberg and Kapikian (1978) demonstrated that antibodies of the Norwalk agents were acquired more slowly than rotavirus in the Washington, D.C. sample and that antibodies were present in 50% of the human population in the fifth decade of life. This suggests that the Norwalk agents are not a major carrier of gastroenteritis in infants and young children but are more likely to be associated with illness in older children and adults.

Astrovirus, calcivirus, and coronavirus. The role of these viruses in diarrhea causation remains unclear at this time (Lam 1982). Each of these viruses has been associated with the occurrence of diarrhea, but they have also been present in the absence of diarrhea.

Parasitic Agents

Parasitic infestations are common in developing countries especially in rural areas. Diarrhea caused by parasitic infestation are generally mild and assume a chronic course (Tharavanij 1982).

Entamoeba histolytica. This pathogenic amoeba usually colonizes in the colon causing inflammation, tissue invasion and ulceration of the intestinal mucosa resulting in diarrhea, often with mucus and bloody stools. The amoeba also can be found in people who exhibit no symptoms.

Giardia lamblia. *Giardia lamblia* is transmitted generally by the ingestion of water contaminated with cysts of *Giardia lamblia*. Infection in humans generally results when between 25 and 100 cysts are ingested with the onset of clinical symptoms usually occurring on day 15 after infection (Walzer et al. 1971). Human infections with this organism occur endemically and worldwide and have been reported from the tropics to the Arctic. Generally, the prevalence rate is from 1.1% to 12.5% with higher percentages in some localities.

Ascaris lumbricioides. This helminth has been estimated to affect approximately 1 billion humans. *Ascaris lumbricioides* is capable of causing diarrhea but diarrhea is not the main feature of this parasitic infestation.

In summary, there are three possible causative types of diarrheal agents (bacterial, viral and parasitic). These agents may inhabit different environments and infect different age groups; therefore, the study of diarrhea must take into consideration these different modes of contamination and infestation.

CHAPTER III

GENERAL RESEARCH DESIGN AND METHODOLOGY

The Research Location

The state of Oaxaca is located along the juncture of the eastern and western ranges of the Mexican plateau and consists mainly of extremely broken mountainous ridges. The geographical location of the village is within the *Mixteca* area of Oaxaca which is normally divided into three regions: the *Mixteca Baja* (lower Mixteca), the *Mixteca de las Coastas* (coastal *Mixteca*), and the *Mixteca Alta* (highland *Mixteca*) (Figure 2) (Spores 1967:4). Santa Cruz Mixtepec is in the governmental district of Tlaxiaco and is situated approximately 18 miles to the west of the town of Tlaxiaco (Figure 3). In the state of Oaxaca the Tlaxiaco uplands are second only to the Oaxaca valley in population density. *Mixteca Alta* is, therefore, the most populous (75,000-100,000) district of the entire area (Spores 1967:55).

The Research Population

Although Kirk (1983) stated that vital statistics (birth, death and census records) for the state of Oaxaca are unreliable, at present they represent the only available information on the population of the region. The population of Santa Cruz Mixtepec was registered at 921 individuals in the 1983 General Census of Santa Cruz Mixtepec. Age and sex distribution within the census

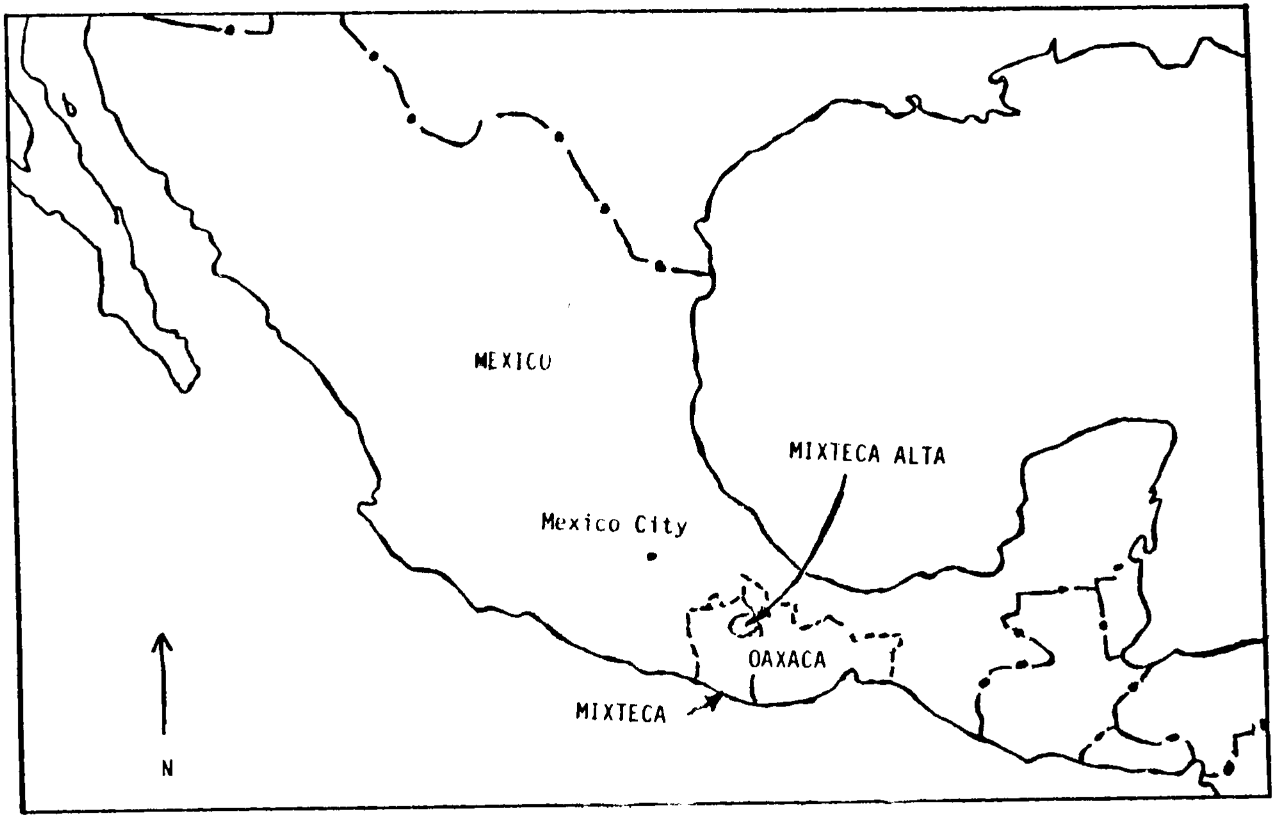


Figure 2. Location of the Mixteca and Mixteca Alta in Mexico (adapted from Spores 1967:5).

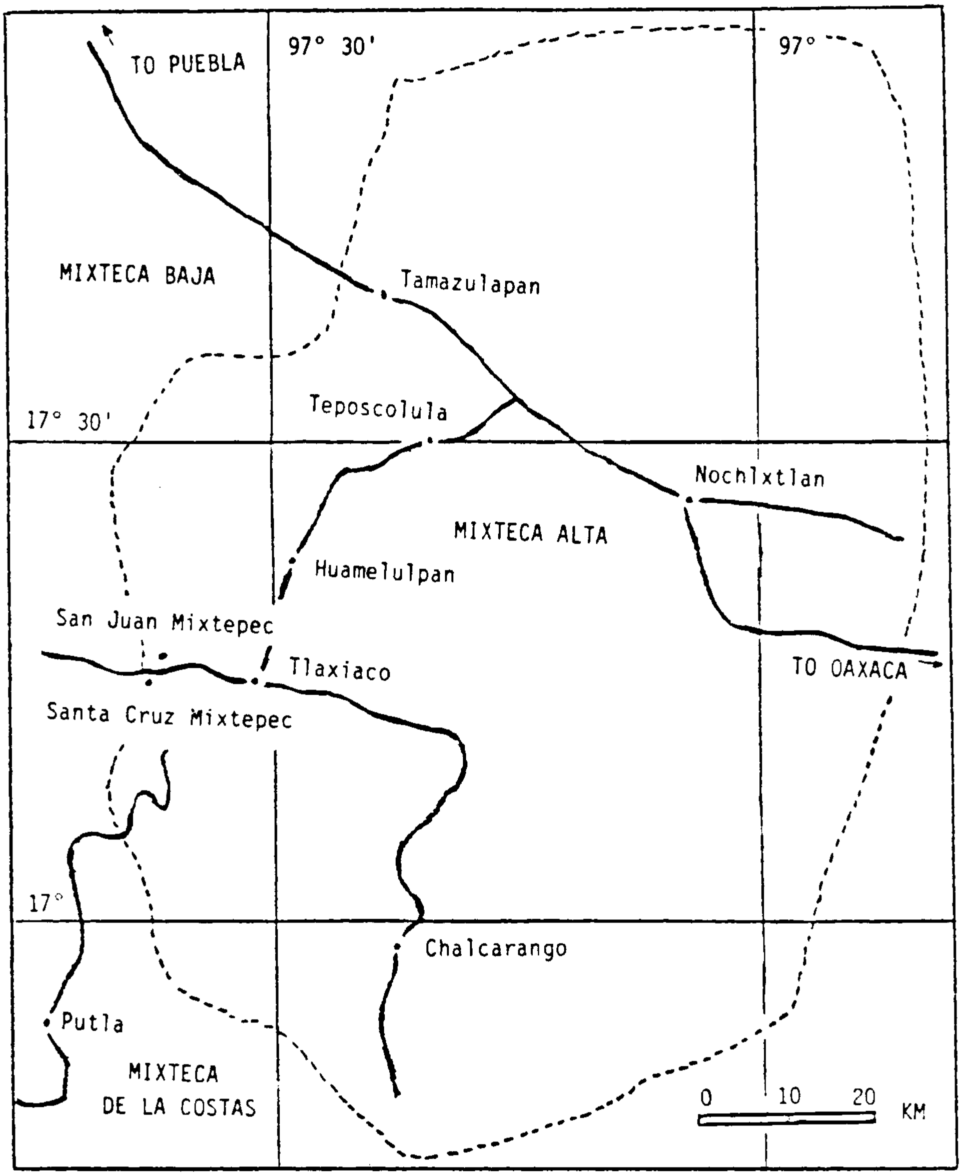


Figure 3. Location of Santa Cruz Mixtepec in the <u>Mixteca Alta</u> (adapted from Spores 1967:7).

indicates that the average age for males was 20.02 years while the average age for females was 21.15 years. When census entries which did not specify either age or sex and entries of males 100 years of age and older were excluded from the population analysis, the average age for males rose slightly to 20.24 while the average age for females was 21.58 years old. Poor birth records, especially for the older segment of the population, makes these rough estimates at best. The age distribution (Table 4) and age pyramid (Figure 4) demonstrate the village is a growing population which is true for most of the developing nations in the world.

The demographic characteristics of the research population are presented in Table 5. Most of the villagers (~89%) had received either no education (48.7%) or education at only a primary level (40.24%). Only 0.56% of the individuals had technical or college training.

Slightly more (27.36%) of the adults in the village are in the husband/wife (casado/casada) category while the single (soltero/soltera) category ranked a close second with 23.21% of the population. The category widow/widower (viudo/viuda) is a third group representing only 4.71% of the adult population. Children (nino/nina), individuals 19 years old and younger, comprised the largest portion of the population with 59.2%.

Most of the villagers reported their occupation to be not known (27.47%) followed by the student/pupil (escolar) 23.99% and homemaker (hogar) 22.42%. The primary occupation of males was farmer/peasant (campesino) with 17.83%.

Table 4. Population of Santa Cruz Mixtepec, according to sex and age, General Census 1983.*

Age Grouping (Years)	Males	Females	Total	~Percent of the Population
0-4	76	91	167	18.7
5-9	79	69	148	16.6
10-14	70	61	131	14.7
15-19	50	32	82	9.2
20-24	30	35	65	7.3
25-29	32	32	64	7.2
30-34	19	26	45	5.0
35-39	30	28	58	6.5
40-44	14	12	26	2.9
45-49	13	10	23	2.6
50-54	8	9	17	1.9
55-59	5	8	13	1.4
60-64	9	6	14	1.7
65-69	1	2	3	0.3
70-74	6	10	16	1.8
75-79	2	1	3	0.3
80-84	2	5	7	0.8
85-89	0	2	2	0.2
90-94	2	5	7	0.8
95-99	0	1	3	0.1
TOTAL	444	448	892	~100.0

*Excluding individuals which did not specify age and/or sex.

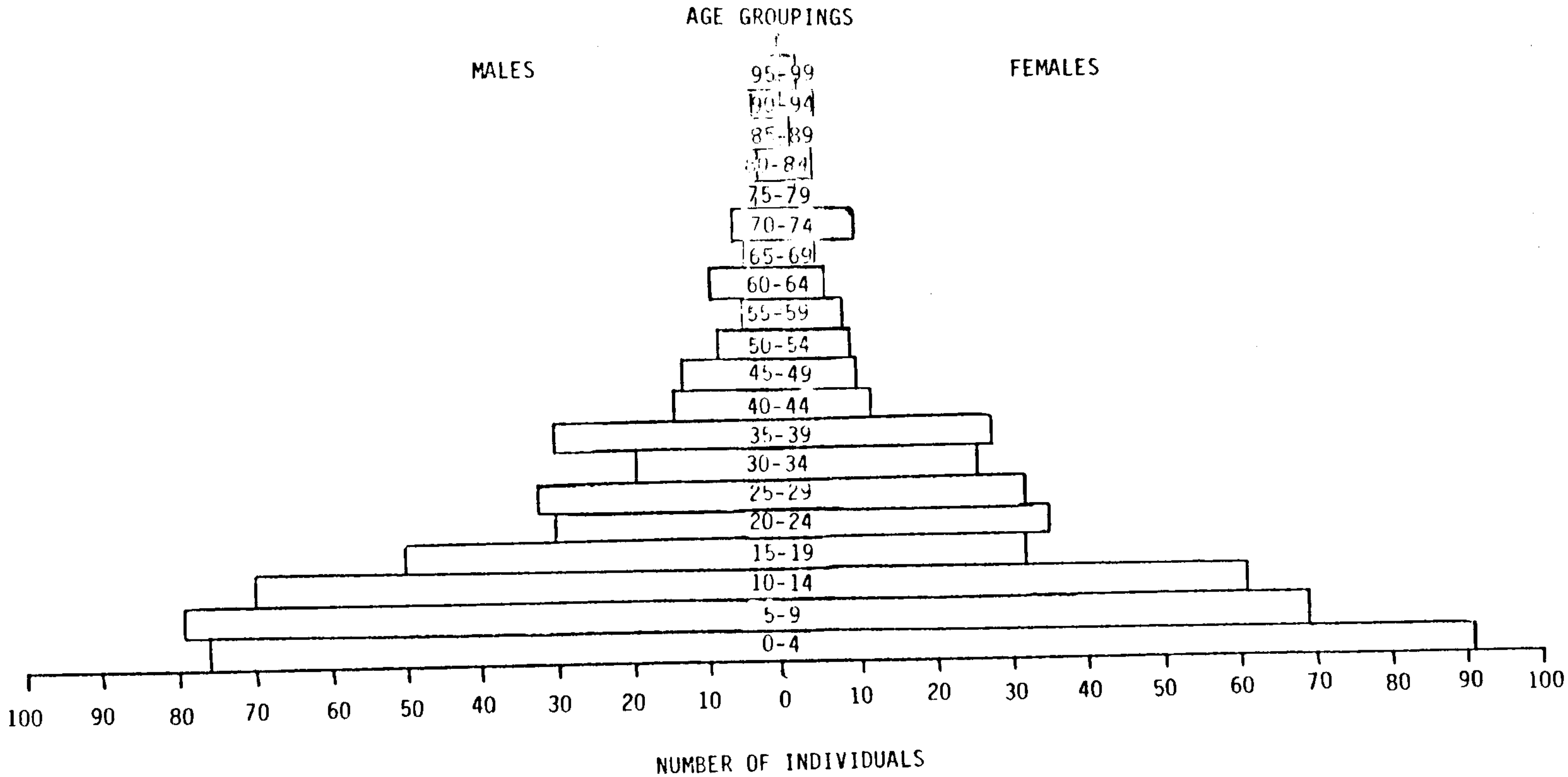


Figure 4. Population age pyramid of Santa Cruz Mixtepec.

Table 5. Demographic characteristics of Santa Cruz Mixtepec population, General Census 1983.

Characteristic	Males	Females	Total	~Percent of the Population
Formal Education				
None	178	256	434	48.70
Kindergarten	10	14	24	2.69
Primary	210	149	359	40.24
Secondary	35	19	54	6.06
Tech/College	3	2	5	0.56
Other	12	4	16	1.78
Marital Status				
Not known	16	14	30	3.36
Husband/Wife	123	121	244	27.36
Single	87	65	152	23.21
Child	216	205	421	47.20
Young Man	3	0	3	0.34
Widower/Widow	6	36	42	4.71
Occupation				
Not known	124	121	245	27.47
Peasant/Farmer	159	0	159	17.83
Housewife	0	200	200	22.42
Student	28	18	46	5.16
Pupil	114	100	214	23.99
Teacher	13	3	16	1.80
Other	10	2	12	1.34
Speak Spanish				
Not known	68	80	148	16.59
Yes	311	181	492	55.16
No	69	183	252	44.84

The isolation of the village of Santa Cruz Mixtepec is demonstrated when the ability to speak some Spanish is examined. Only 55.16% of the villagers speak Spanish but the individuals were not asked about their Spanish fluency. The major portion of oral governmental business in the village is conducted in the Mixtec language, while the written portion must be in Spanish. This limits the number of individuals available for the town's major offices. Since daily conversations in the village is in the Mixtec dialect, the villagers' only opportunity to converse in Spanish is limited to outside contact. In the village school lessons are taught only in Spanish and if villagers wish to sell their major cash crop (avocadoes) to vendors from outside the Mixteca area, they must be able to negotiate a "good" price in Spanish.

Preliminary Procedures and Investigation

During the preliminary phase, the general topic of this investigation, that is, possible factors (environmental, socio-cultural, and health) related to the incidence of diarrhea in a remote Mexican village were examined. During the fall of 1982 through the summer of 1983, the author developed this project by reviewing pertinent literature, and engaging in observation, participant observation, laboratory analyses, and interviewing the Mixtec people. A trip to the village during the summer 1983 was made to become familiar with the culture, environment, and health problems of this group.

Following the review of literature and accustomization to the culture and environment, the research goal and specific aims were defined. The goal of the study was to examine the incidence of diarrhea in the village and its relationship to environmental, socio-cultural, and health status indicators. The information generated pertaining to parasitic and bacterial infestation, physical growth, socio-cultural practices and beliefs would serve as a basis for culturally-relevant diarrheal control program in Santa Cruz Mixtepec. Several methods were used to evaluate bacterial and parasitic infestation, assess anthropometric characteristics, identify possible vectors and routes of contamination, and to assess socio-cultural practices. Permission to conduct the study was obtained from town officials (Appendix A). Prior to actual recruitment of participants, a town (village) meeting was held to inform the villagers of the goal and objectives of the study. Approval for research involving human subjects was obtained from The University of Tennessee, Knoxville, Human Subjects Committee (Appendix B).

Data Collection

During the summers of 1983 and 1984, the author collected data while residing in the village of Santa Cruz Mixtepec. The author resided with the Thomas Ibach family who were well accepted within the village setting. Thomas Ibach has completed a Master's degree in Medical Anthropology at The University of Tennessee, Knoxville, and was available during the winter months to aid in the development and analyses of this project.

The sample utilized in this investigation was drawn from two sources. The primary source was the village medical clinic where everyone who came for treatment (of any type) was asked to participate in the study. The goals of the project, the procedures to be followed, and the time commitment were explained. If the prospective subject agreed to participate, the anthropometric measurements and the interview followed. All interviews were conducted in the village medical clinic. Methods of data collection are delineated in later chapters. The financial reimbursement occurred only after the fecal specimen was delivered to the health clinic. Individuals also volunteered to participate in the study. Reimbursement to families participating consisted of 100 pesos or approximately $0.50 (USA) based upon current exchange rates.

Data Reduction and Analysis

Each data item was assigned a numerical code. Data codes were keypunched on cards and read directly into the DEC-10 system at The University of Tennessee Computing Center (UTCC). The IBM 360/65 at the UTCC was used for most calculations employing a package computer program, Statistical Analysis Systems (SAS). Specific data reduction and analysis procedures used for various sets of data are discussed in detail in the later chapters.

Characteristics of the Research Sample

The age distribution of the study sample is presented in Table 6. Of the 177 participants, 98 were females and 77 were males.

Table 6. Age distribution of subjects in the research sample.

Age Grouping (Years)	Males	Females	Total	~Percent of the Sample
0-4	23	16	39	22.2
5-9	22	20	42	22.3
10-14	8	13	22	12.4
15-19	3	5	8	4.5
20-24	2	7	9	5.1
25-29	4	6	10	5.7
30-34	1	10	11	6.3
35-39	4	8	12	6.8
40-44	3	4	7	4.0
45-49	2	0	2	1.1
50-54	1	1	2	1.1
55-59	2	1	3	1.8
60-64	3	1	4	2.3
65-69	1	1	2	1.1
70-74	0	1	1	0.6
75-79	1	0	1	0.6
80-84	1	0	1	0.6
85-89	0	0	0	0
90-94	0	0	0	0
95-99	1	0	0	0.6
TOTAL	79	98	177	~100.0

Approximately 61.4% of the participants were under 20 years of age. This percentage closely approximates the 59.2% found in the 1983 general census age distribution.

The demographic information presented in Table 7 represents 133 of the 177 participants (or ~75%) on which general census information could be obtained. Most (91.73%) of the subjects in the research sample had either received no formal education (55.64%) or had received education only at the primary level (36.09%). Only one person (0.75%) has any technical or college training.

The child (nino/nina) category constitutes a majority (54.86%) of persons in the research sample, followed by husband/wife (casado/casada) with 24.88%. Of the remaining participants 9.03% of the adult portion were single (soltero/soltera) and 4.71% were widowed (viudo/viuda).

The most designated occupation was that of not known (35.08%) for the male portion and homemaker (hogar) 27.82% for the female portion. Student (estudiante) and pupil (escolar) accounted for the young portion (24.82%) of the sample. When an occupational designation was made for the remaining male portion of the sample, the occupation was farmer/peasant (campesino) with 12.03%.

The ability to speak Spanish is crucial for the villagers to be able to communicate with persons from outside of the Mixteca area. Only 44.87% of the research sample can speak Spanish, though the degree of fluency was not specified, compared to 28.87% which state they can not speak Spanish while 22.56% did not specify their linguistic ability.

Table 7. Demographic characteristics of subjects in the research sample.*

Characteristic	Males	Females	Total	~Percent of the Sample
Formal Education				
None	31	43	74	55.64
Kindergarten	3	4	7	5.26
Primary	24	25	49	36.09
Secondary	3	0	3	2.25
Tech/College	0	1	1	0.75
TOTAL	60	73	133	
Marital Status				
Not known	2	1	3	2.26
Husband/Wife	15	23	38	28.58
Single	4	8	12	9.03
Child	38	35	73	54.88
Young Man	1	0	1	0.75
Widow/Widower	0	6	6	4.51
TOTAL	60	73	133	
Occupation				
Not known	25	19	44	33.08
Peasant/Farmer	16	0	16	12.08
Housewife	0	37	37	27.82
Student	0	2	2	1.50
Pupil	16	15	31	23.31
Other	2	1	3	2.20
TOTAL	60	73	133	
Speak Spanish				
Not known	17	13	30	22.56
Yes	31	34	65	48.87
No	12	26	38	28.57
TOTAL	60	73	133	

*Includes those individuals on which General Census information could be obtained 133 of 177 participants, or ~75% of the research sample is represented.

The research sample does not appear to deviate grossly from that of the general census information. Thus, the research sample was accepted as being representative of the population in the village through the documentation of the demographic characteristics.

CHAPTER IV

ENVIRONMENTAL FACTORS ASSOCIATED WITH DIARRHEA

Review of Literature

An unsanitary (unhygienic) environment is frequently mentioned as a major contributor to diarrheal causation. An unsanitary environment allows the agent to survive and come into direct contact with the recipient, thus facilitating the spread of diarrhea. The survival time of diarrheal agents in favorable environments differs from *Salmonella* species and *Escherichia coli* which live for slightly less than a year to *Entamoeba histolytica*, *Vibrio cholera* and *Shigella* species surviving less than one month (Table 8).

There are many factors which determine the precise survival lengths of diarrheal agents (Noche 1982). These factors facilitate diarrheal episodes by allowing the agent to survive as long as possible before coming into contact with the recipient, thus increasing the likelihood of a diarrheal episode.

Seasonal Variation

In developing countries, most cases of diarrhea occur during the hot, humid, wet season (Lieberman et al. 1984) and are generally associated with enterotoxigenic bacteria, such as *Shigella* species and other bacteria (Black et al. 1980; Mata et al. 1982). During this season there is an apparent increase in bacterial contamination of water and foods (Black et al. 1982). Rotaviruses are more frequent

Table 8. Survival of diarrheal agents in the environment.*

Time		Diarrheal Agents
Less than one year	:	*Salmonella* species *Escherichia coli*
Less than six months	:	*Giardia lamblia* *Salmonella typhi* *Yersinia* species
Less than one month	:	*Entamoeba histolytica* *Vibrio cholera* *Shigella* species

*Modified from World Health Organization (1980).

in the cold dry season, especially in countries with temperate climates (Flewett et al. 1975; Kapikan et al. 1978; Konno et al. 1978). As a nation moves from a traditional to a more modern way of life, the "winter" viral diarrhea peak becomes more prominent, and the "summer" bacterial diarrhea season decreases in importance. Chambers et al. (1979:28) stated that "the seasonality of diarrhea cannot be ignored as it is one of the factors determining rural poverty."

Water

Proper use of water supplies can decrease the incidence of water related disease and diarrheal disorders (Schneider et al. 1978). The systematic improvement of the bacteriological quality of water does not necessarily eliminate water-borne diseases (Bloom 1984). A pure water supply would reduce the incidence of typhoid fever by 80% and that of amebiasis by 50% (White et al. 1972). Efficacy of the water supply is held to be a function of population density, and of more importance is the number of persons using the given source (Cruickshank et al. 1976; Muttamara and Krishaswamy 1982).

Information obtained from communities in rural Guatemala by Shiffman and Schneider (1976) revealed that water from contaminated wells may be further contaminated by its placement in transport and storage vessels. In a community with a relatively pure piped intra-domiciliary water system, they found that contamination increased 36% to 44% when placed into these domestic containers.

Trivedi et al. (1971) investigated the impact of water supplies on the incidence of diarrheal disorders in Kampua, India. They found that the socio-cultural and religious practices of the population enhanced the effect of a clean water supply in reducing the incidence of diarrhea. Other researchers (Hollister et al. 1955; Schliessman 1959; Bradley 1970; White et al. 1972; Unrau 1975) found that socio-cultural practices tended to contribute to the incidence of diarrhea.

Nonhuman Sources

Arthropods. Flies, roaches, and mosquitoes have been documented as vectors of diarrheal causative agents (Echeverra et al. 1983). Flies may harbor enterotoxigenic *Escherichia coli*, *Shigella* species and *Vibrio cholera* during the months in which the incidence of diarrhea may be the highest.

Animals. The fecal matter of grazing animals close to the home environment increases the likelihood of the agent coming into contact with the recipient (World Health Organization 1980). Food and water play an important part in the transmission of parasitic zoonoses. WHO Expert Committee on Microbiological Aspects of Food Hygiene (WHO 1976b) grouped food-borne parasites into two categories:

1. Parasites of which the infective stage occur naturally in food (meat, fish, molluscs, crustacea, etc.)--e.g., *Taeina* species, *Diphyllobotrium* species, fish borne trematodes, *Trichinella* and *Toxoplasma*.

2. Parasites that are derived from the environment (soil, water, etc.) from animals, or from food handlers, and whose infective stages occur as contaminants in food--e.g., *Ascaris*, *Entamoeba*, and *Giardia*.

Other Possible Environmental Contacts

Intestinal bacterial colonization of rural Guatemalan newborns and infants can be influenced by their early contact with enteropathogens, especially *Shigella*, *Salmonella*, and *Escherichia coli*. This was not only due to contamination with the feces of the mother during delivery (Mata et al. 1967), but may also be due to repeated contact with unclean nipples during breast feeding (Mata et al. 1969; and Wyatt and Mata 1969).

Food

Food is frequently contaminated by the female head of the family while it is being prepared (Capparelli and Mata 1975). The main source of the contamination is her unclean hands. Washings from the hands of rural mothers with children below the age of four years were more heavily contaminated than washings from nurses taking care of malnourished children of the same age at the Institute of Nutrition of Central America and Panama's (INCAP) metabolic ward (Schneider et al. 1978).

Weaning foods may also play a part in diarrheal causation of children. In The Gambia (Barrell and Rowland 1979) and Bangladesh (Black et al. 1982), weaning foods were found to carry enteric bacteria (Table 9). Contamination of weaning foods increased during the rainy and warm months when conditions within the home favored multiplication of microorganisms in food.

At local food markets in nonindustrialized societies or in rural areas of industrialized societies, food is often placed in heaps on the ground, on mats or in open containers, and is exposed to dust and flies. Non potable water may be used to freshen foods during display. Thus, food is often contaminated by a large number and great variety of microbes, some of which are pathogens (WHO 1984b).

Availability to Health Care

The effect of residential distance from a clinic treating diarrhea was studied by Rahaman et al. (1982). The more severe cases of dehydration consistently lived farther from the treatment facility than those with less severe cases of dehydration.

Table 9. Fecal bacteria and other potential enteric pathogens in village weaning foods.

Country	Food	Bacteria Log 10/g or ml
Guatemala (1) (Cauque)	Tortillas	*Escherichia coli*, 3-7 *Staphylococcus aureus*, 7-8 *Bacillus cereus*, 9 *Clostridium* species, 1-2
Gambia (2) (Keneba)	Cereal gruels, milk	*Escherichia coli*, 5 *Staphylococcus aureus*, 2-6 *Bacillus cereus*, 4-6
Bangladesh (3) (Matlab)	Rice, milk	*Escherichia coli*, 2-7

(1) Capparelli and Mata 1975.

(2) Barrell and Rowland 1979.

(3) Black et al. 1982.

Agricultural Policy

Recent agricultural policy in Mexico emphasizes support for commercial crops as a step toward self-sufficiency in food production. In southern Mexico, cooperative farmers receive agricultural support for sugar, cattle, rubber, and beans. Farmers who choose to divert all of their farmland to cash crops were not able to provide adequate diets for their children (Brown 1984).

Research Hypotheses and Methodology

Research Hypotheses

In an effort to document the interrelationship between diarrhea and environmental components in the village of Santa Cruz Mixtepec, several facets of the environmental context were sampled to test the following hypotheses:

1. Diarrheal episodes (total number of reported diarrheal episodes) are more frequent during the wet season (May to November) than in the dry season (November to May).

2. There is no significant difference in the number of rooms in a participant's house and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

3. There is no significant difference in the number of persons who reside in the participant's home and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

4. There is no significant difference in the number of animals (ox, pigs, chickens and turkeys, dogs, burros) a participant's

family owns and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

5. There is no significant difference in the number of trips a participant's family makes to gather wood per month and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

6. There is no significant difference in the number of hours the participant's family allows the fire to burn in the morning or evening and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

7. There is no significant difference in whether the participant's family obtains their water from the faucet, spring, or river and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

8. There is no significant difference in whether parasitic agents are present in the participant's stool and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

Data Collection

Several techniques and informational sources were employed to test the stated hypotheses. All clinic records of village residents were reviewed to obtain information relating to diarrheal episodes. The day, month, and year of the clinic visit along with the number of days since onset of diarrheal symptoms were recorded.

Interviews were conducted to ascertain environmental factors which are related to diarrheal causation. These interviews followed a schedule (see Appendix C) asking the number of persons living in the house, number of rooms in the house, number and type of animals (Burro, chickens, dogs, ox and pigs) present, and water sources (river, centralized water source, and/or spring) utilized. Participant observation was utilized during home visits to confirm the replies and to add information to each interview.

Laboratory analyses for the presence of bacteria and parasites was conducted in order to assess the degree of environmental contamination. These analyses were conducted on a number of possible vectors including water, feces, food, and soil. Different laboratory techniques were utilized due to the variety of vectors tested.

Water sources. The membrane filter technique was utilized to determine the amount (degree) of bacterial contamination. In this technique, water to be tested was suctioned, by means of an air pump, through a membrane filter (Micro Filtration Systems 1983). This laboratory analysis was done by an assistant who had previous experience with this laboratory procedure.

The standard collection protocol was for the water sample to be collected in a sterile bottle and brought back to the clinic to be tested within 24 hours. The exact procedure for this analysis differed slightly depending upon the sample source, the central water system (capped spring) or river water (Appendix D).

Fecal sources. The iodine preparation (Appendix E) was utilized in the examination of all fecal specimen regardless of source. All specimens were examined microscopically under low power for location of parasitic ova (fertilized and unfertilized), worms, flagella, and amoeba. High power was utilized to aid in viewing diagnostic features of the parasite.

Food sources. Food sources (fruits and vegetables) were purchased at the Friday open air market in San Juan Mixtepec. These foods' outer surface (skin) was subjected to microbiological analysis (Appendix F) to ascertain whether they might serve as a link in diarrheal causation for the villagers of Santa Cruz Mixtepec.

Soil sources. Soil was analyzed (Appendix E) utilizing the same procedures as were used for the fecal sources. Samples for this analysis were collected during both rainy and dry days.

Data Analysis

All statistical computations were done using the SAS package on the IBM computer in the University of Tennessee Computing Center. Pearson's chi square statistic was utilized to test whether the presence of parasitic agents was associated with diarrheal episodes, whether there was a significant difference in diarrheal episodes per season, and whether there was an association between environmental factors of nominal nature (water sources used: faucet, spring, and river; and the presence of fecal parasites: *Ascaris lumbricoides*, Entamoeba histolytica and Giardia lamblia) and diarrheal incidence. For each of these nominal variables, diarrheal incidence was changed from a continuous variable to a categorical variable to reduce the scarcity of the contingency tables. The mean for diarrheal incidence (number of diarrheal episodes/years since first reported case of diarrhea) was 0.26. The categorical divisions were:

NONE: Diarrheal incidence equals zero.

MILD: Diarrheal incidence greater than zero but less than 0.30.

MODERATE: Diarrheal incidence greater than or equal to 0.30 but less than 0.50.

SEVERE: Diarrheal incidence equal to or greater than 0.50.

All other variables (excluding nominal) were tested for association with diarrheal incidence utilizing regression analysis for each environmental factor. An alpha level of 0.05 was chosen to designate a significant association for all statistic tests. Regression analysis was further utilized to obtain a model of environmental factors that provides the best possible fit for the variation in diarrheal incidence.

Results and Discussion

Diarrhea and Season

The wet season is defined by most Mexicans as 15 May to 14 October while the dry season is defined as 15 October to 14 May. For this research, this seasonal delineation has been broadened to include the transitory periods for each season. Thus, the wet season includes 1 May to 1 November, while the dry encompasses 1 November to 1 May.

Chi square analysis was used to find if there was a significant difference in diarrhea cases per season (Table 10). The computed chi square (52.52, 16, <0.001) indicated that there was a significant difference in diarrheal cases per season with the onset of the wet season increasing the likelihood of a diarrheal episode. When the amount of precipitation and reported diarrheal episodes were graphed together (Figure 5), it was found that both precipitation and diarrheal increased and decreased in a similar manner.

Laboratory Analyses of Environmental Vectors

The results of laboratory analyses revealed that all tested sources of vectors may serve as possible routes of contamination. Water, food, soil, and feces all contained either bacteria and/or parasites which are known causative diarrheal agents.

Water sources. For the purpose of this study a numbering system was utilized for the various centralized water dispensing points (faucets) which are located on Figure 6. The test results of water samples from individual faucets and the river were recorded and expressed as number colonies of *Escherichia coli* per 100 milliliters (Figure 7). The results from the two testings of the faucets show discrepancies that should not be present in a closed water system. Although 11 of the 17 faucets were contaminated with

Table 10. Diarrheal episodes per season 1969-1984.*

Year	Season Dry (1)	Season Wet (2)	Total
1969	16	25	41
1970	8	15	23
1971	20	36	56
1972	31	45	76
1973	16	33	49
1974	14	38	52
1975	34	39	73
1976	21	49	70
1977	27	49	76
1978	28	60	88
1979	19	73	92
1980	9	73	82
1981**	10	26	36
1982	11	73	84
1983	33	49	82
1984***	10	28	38

*Pearson's chi square (52.52, 16, <0.001).

**Clinic closed for approximately half of the year.

***Full year not reported (January to July 1984).

(1) Includes months: January, February, March, April, November, and December.

(2) Includes months: May, June, July, August, September, and October.

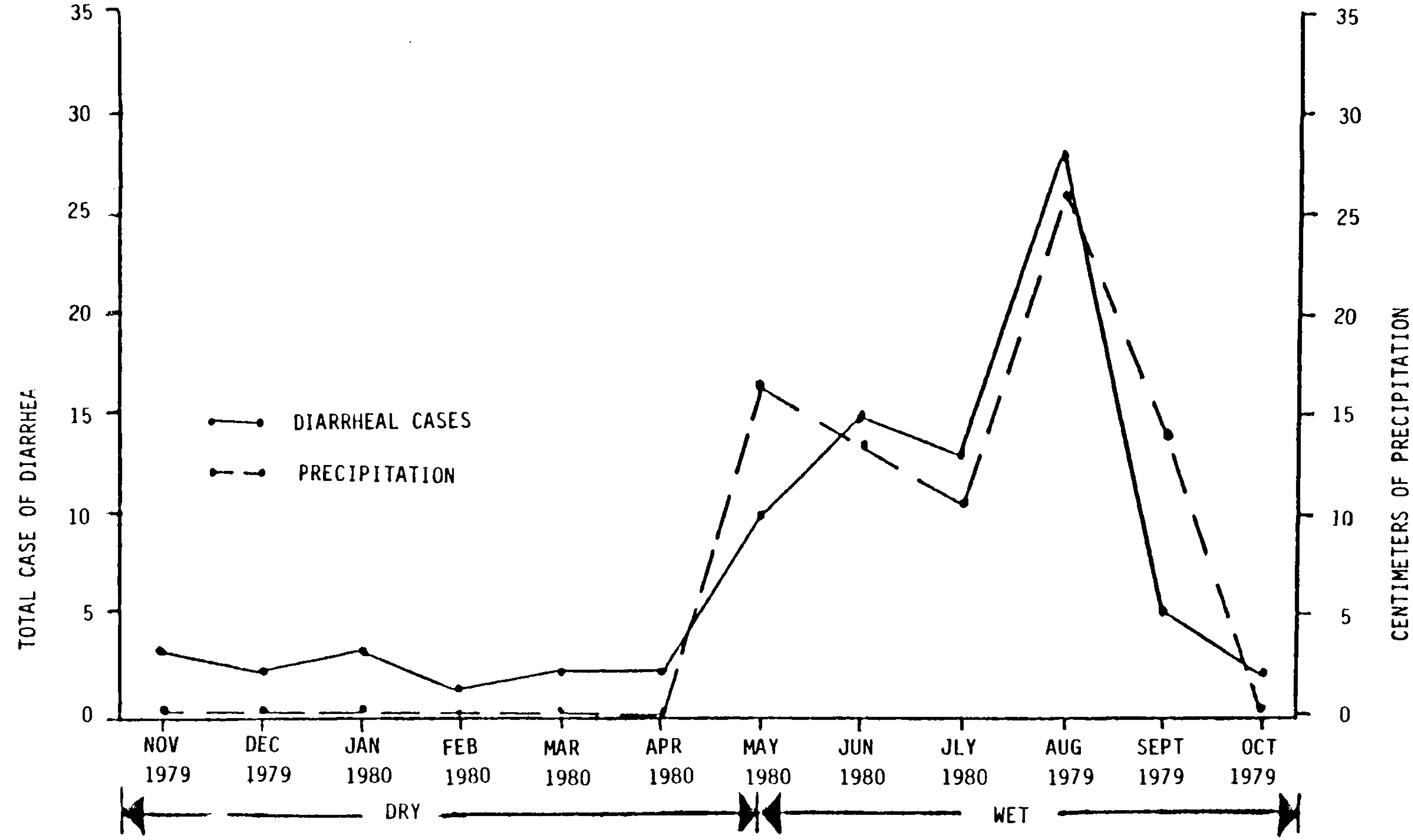
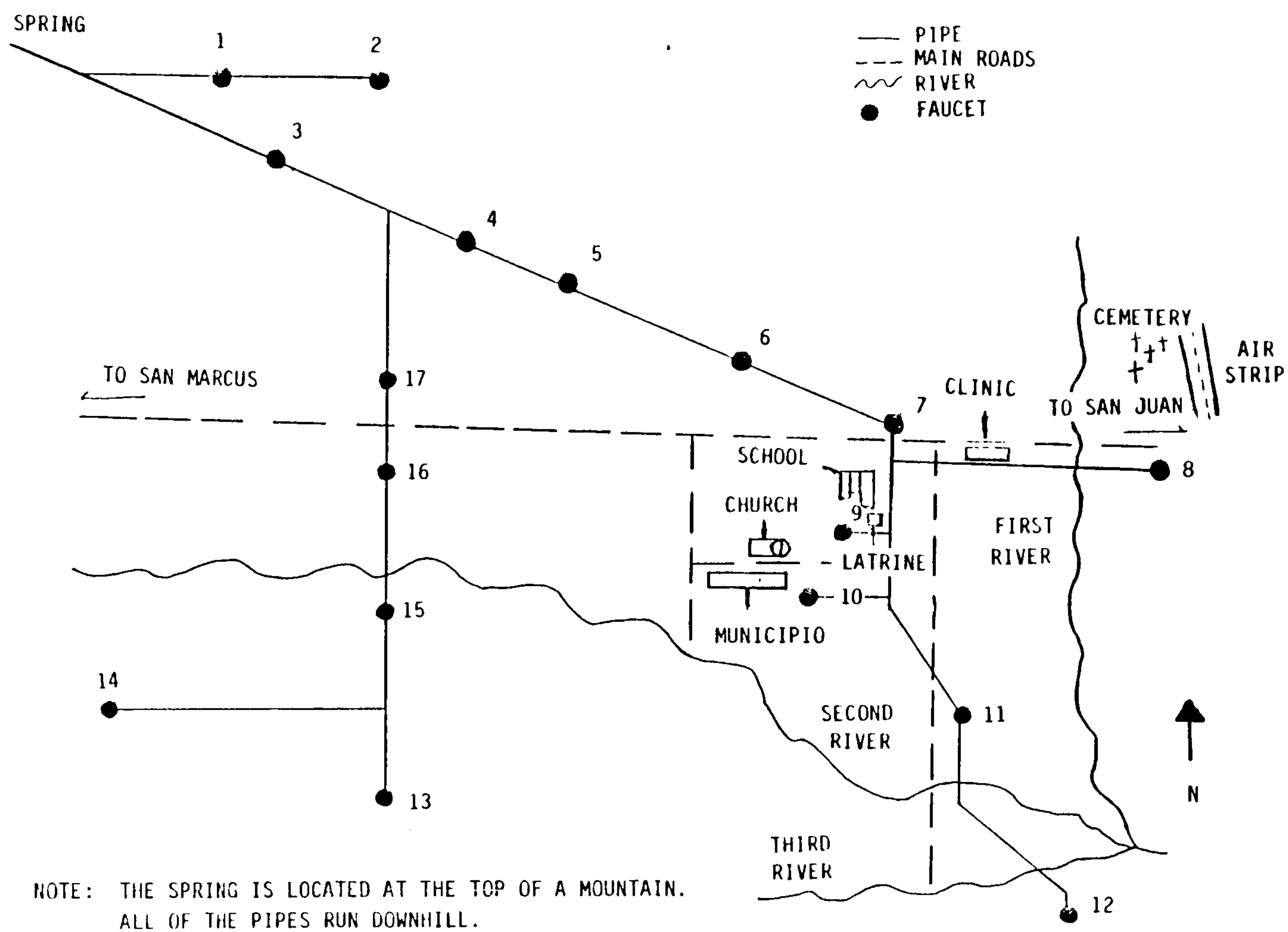


Figure 5. Amount of precipitation and number of diarrheal episodes.



NOTE: THE SPRING IS LOCATED AT THE TOP OF A MOUNTAIN.
ALL OF THE PIPES RUN DOWNHILL.

Figure 6. Map of faucet locations in Santa Cruz Mixtepec.

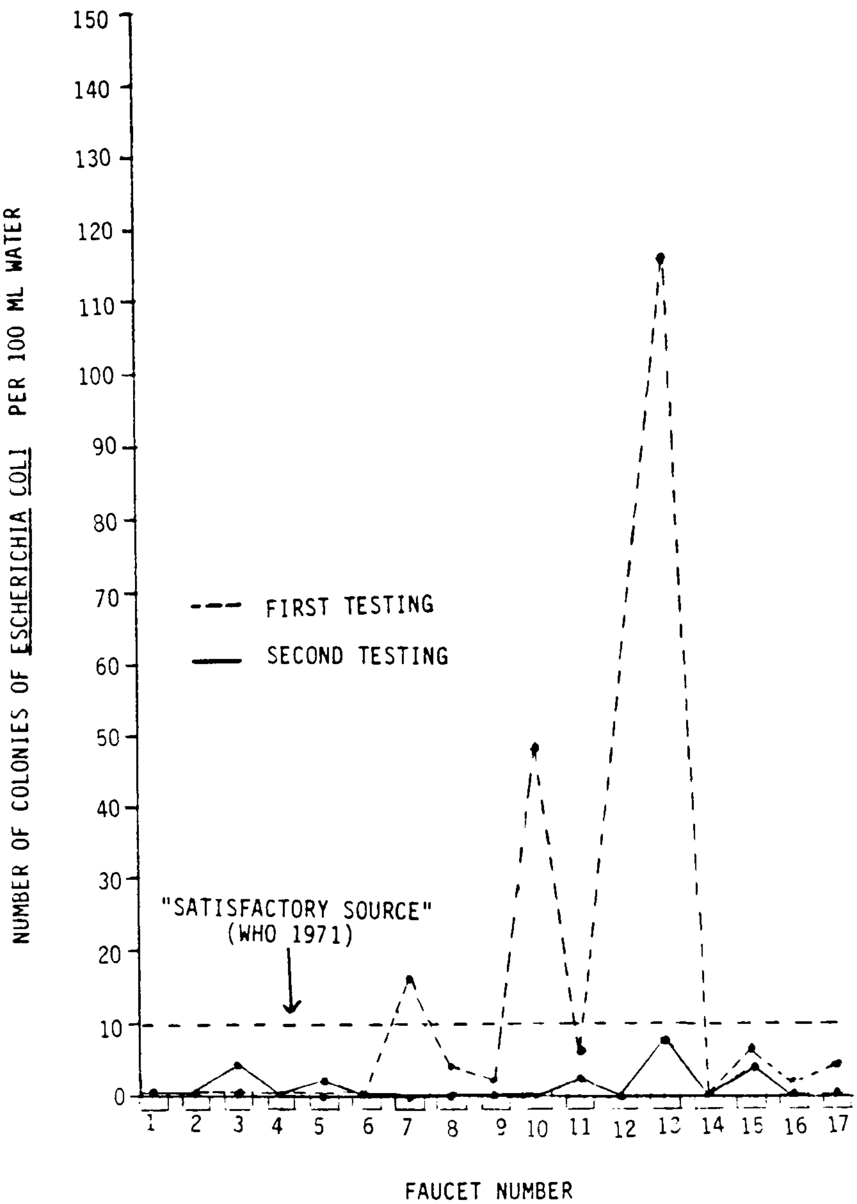
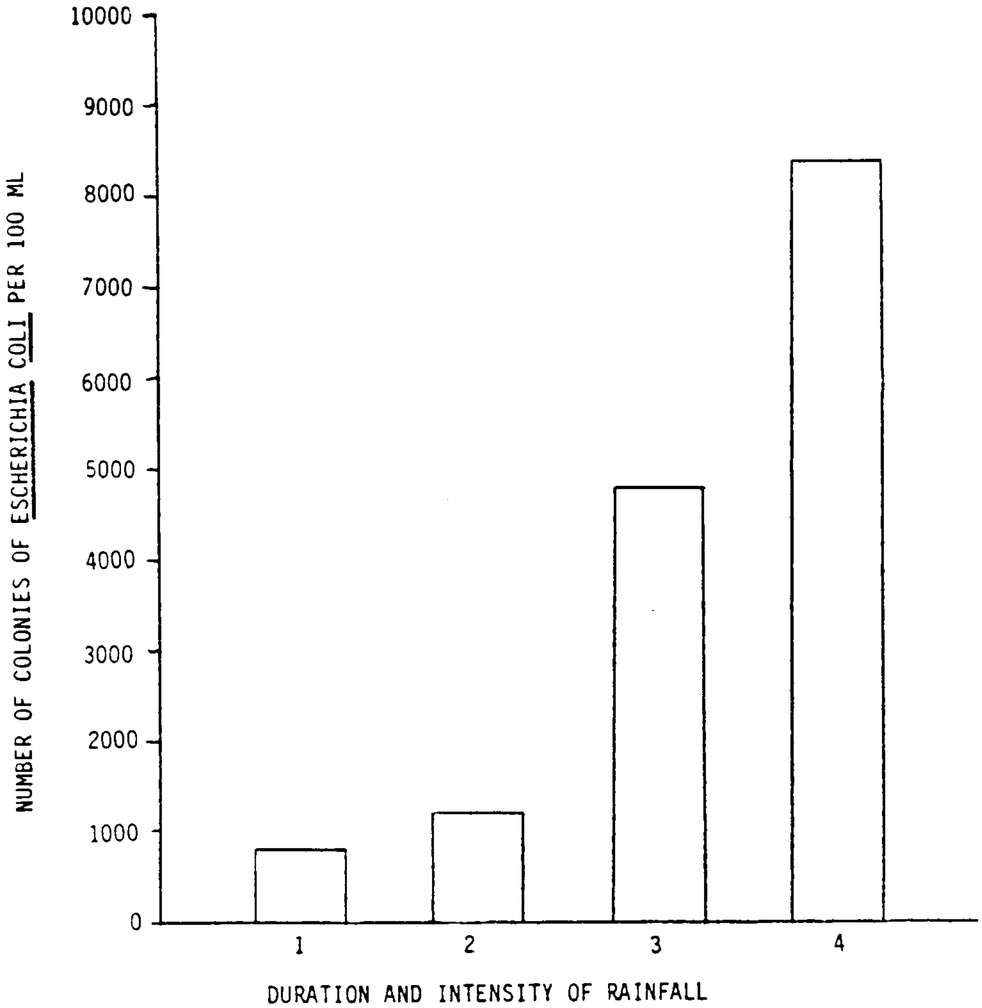


Figure 7. Total colonies of <u>Escherichia</u> <u>coli</u> per faucet for each testing.

Escherichia coli, only 3 of the 17 are contaminated beyond the drinking water standards for individual or small community supplies for a "satisfactory source" as recommended by the World Health Organization (1971). The standard for a "satisfactory source" specified that the water testing should yield less than 10 coliforms per 100 milliliters (ml) and that if Escherichia coli were repeatedly found, the supply should, as a general rule, be condemned.

Faucets 7, 10, 13 are those sources located at high traffic and/or high demand areas which persons other than the villagers of Santa Cruz Mixtepec would utilize. Faucet 7 is located on the road which leads from San Juan Mixtepec to San Marcus. Faucet 10 is located close to the governmental agencies such as the municipio and conasupo. Faucet 13 is located on the top of the hill and is the last available source of clean water for villagers on the hill and beyond. Villagers who do not use this faucet will use the river as it is their most convenient source of water.

Although there are three rivers in the village, the majority of the testing was done on the second river since it is the largest and is used more often than the others as a source of water. The results of the tests on the river (Figure 8) demonstrated that the variables which most affect the contamination of the river are both the duration and the intensity of the rainfall. This is explainable in terms of the rain effects on the



1 = No rainfall for 24 hours

2 = One afternoon of steady rain (2:00-6:00 p.m.); prior to this no rainfall for 24 hours

3 = Heavy rain, afternoon and night; prior to this no rainfall for 24 hours

4 = Steady, sometimes hard, rained for 3 days

Figure 8. Duration and intensity of rainfall compared to the amount of fecal contamination in river water.

land, that is, harder and longer rains wash more topsoil into the river than lighter and shorter rains do. The topsoil that is washed into the river contains feces, both human and animal, which causes the amount of fecal contamination to rise. Thus, the amount of muddiness (lack of clarity) can be utilized as a rough indicator of the possible degree of contamination of the water.

Domestic containers. When the villagers get water from any of the faucets from the community water supply (capped spring), they utilize a container whether it be plastic, metal, or clay for transporting and/or storing the water. Each time the water collector arrived at the tap, they rinsed their collection vessel but the drawer did not usually wash their hands. The water collector supported the collection vessel with his/her hand as it filled because the area around the tap might be slippery or muddy. Once the filled water container was brought back to the house, its contents were usually poured into clay pots of various sizes or its contents were left in the gathering vessel. Although water collection containers are rinsed at each filling at the source, the storage containers have water continually added and removed but are seldom, if ever, washed or rinsed out.

These storing containers were left in the cookhouse uncovered and exposed to all possible contamination ranging from falling debris, children's and infant's probing hands, to animals (dogs) taking a drink or by invasion of flies and other arthropods. This bacterial and/or parasitic contamination was controlled to some extent by the shape of the clay container. These containers are not only utilized for water but are also used to soak corn and beans. The container's shape consists of a slightly narrowed base, a broad mid-section, and a very narrow spout area. By drastically narrowing the spout area of this container or any container, one decreases the likelihood of bacterial and/or parasitic contamination proportionally through decreasing the surface area of the water that is available at any given time for bacterial and/or parasitic contamination. The possibility of contamination could be further decreased by the placing of a cover over the spout area of the vessel and total surface area of the bucket.

In contrast to the domestic clay container, the bucket's possible area exposed to bacterial and/or parasitic contamination is greater. The typical bucket utilized in the village is narrowest at the base, broader at the midsection, and broadest at the upper lip of the bucket. Both containers are set on the floor of the cookhouse and they are extremely close to the actual soil which contains contamination.

Water is drawn from the storage vessel by scooping with a gourd or mug, which is used occasionally for other household purposes. Unless the scoop (dipper) was used for other purposes, it was seldom rinsed or washed out.

Soil sources. All soil samples contained *Escherichia coli*, *Entamoeba histolytica*, and *Ascaris lumbricoides*, occasionally *Giardia* lamblia was found. All of these bacterial or parasitic agents are known to cause diarrhea at some point in their infestation. Ascaris lumbricoides eggs are non-infective in stool specimens, and become infective for man only after a two week or longer period of embryonation in the soil where they remain infective for extended periods of time. Both Entamoeba histolytica and Giardia lamblia cysts in stool specimens have the ability to be infective if the mature cysts are ingested in food and/or water contaminated with feces. At the end of the two week cycle in the soil, Ascaris lumbricoides is infective for two more weeks, while Giardia lamblia is infective for six months, and Escherichia coli is infective for an entire year. The presence of diarrheal agents in the soil increases the chance that they might be further perpetuated through human contact. All of the houses, both cooking and sleeping, have dirt floors. Although a majority of the sleeping houses are constructed solidly with only a door as the major opening, the cook houses are constructed of wood which is loosely bound together and rain may either leak or flow into cook houses thus facilitating the contact between agents and recipient.

Food sources. All food sources (fruits and vegetables) purchased at the San Juan Mixtepec market contained Escherichia coli in numbers too numerous to count on the lowest possible dilution of 1:1000 and a few colonies of Staphylococcus species (unable to differentiate), on the exterior skin portion. The contamination with Escherichia coli represents fecal contamination while contamination with Staphylococcus species implies contamination due to contact with improperly cleansed wounds (open lesions or cuts) and/or skin infections (WHO 1976b). A suggestion has been made by the International Commission on Microbiological Specifications for Foods (1974) that Staphylococcus aureus should be treated as an indicator in raw foods and as a pathogen in cooked foods. Thus, this organism may be a good indicator of contamination from nasopharyngeal and skin sources of man.

The staple of the villager's diet is corn tortillas which are prepared each morning for the entire day's consumption. The homegrown corn is soaked overnight in lime water to make preparation of tortillas easier. The next morning, the lime water is drained off and the soaked corn is worked to a paste on the metate. Escherichia coli colonies were too numerous to count (TNTC) in the bacteriological analysis of the discarded lime water.

Following the formation of a paste, the paste is worked into a tortilla form by the women using a pair of waxed paper circles within which the paste is placed with additional water being added as needed for the formation of the tortillas. The waxed paper was then rolled over by the rolling pin and rotated so that the corn paste was evenly dispersed into the proper shape. Depending on the woman, the above procedure might be done by hand rather than with the pin. The waxed circles are used continuously each morning, and are not cleaned or discarded until the woman believes that they are worn out. In bacteriological analyses, Escherichia coli was found to be present in and on both the waxed paper circles and in the water utilized to dilute the corn paste.

Fecal sources. In human sources, a fecal examination for parasitic agents was performed for 165 of 177 participants. Of the 165 fecal specimens submitted for microscopic analysis, 133 participants or 80.16% of these samples had at least one identifiable parasitic agent. The most frequently found fecal parasite was *Entamoeba histolytica* in 73.3% of the specimens, followed by *Ascaris lumbricoides* in 22.11% and *Giardia lamblia* in 5.45% of the specimens (Table 11). A combination of two or more parasites in a single specimen was present in 23.03% of the specimens. The most prevalent parasitic combination was of *Entamoeba histolytica* and *Ascaris lumbricoides*.

Table 11. Frequency of fecal parasites in the research sample.

Parasite	Present		Absent	
	Frequency	Percent	Frequency	Percent
Ascaris lumbricoides	53	22.10	112	67.90
Entamoeba histolytica	121	73.33	44	26.67
Giardia lamblia	9	5.45	156	94.55

The percentage of parasitic agents for the research sample according to age groupings are presented in Table 12. The highest percentage of infestation for each parasite occurs in the 5 to 14 age grouping. When these percentages are plotted, the pattern of infestation for each parasitic agent appears to be similar (Figure 9).

Animal sources. Examination of animal (burro, pigs, sheep, and cows) fecal material (Table 13) demonstrated the presence of the same parasites that were found in humans. There is little evidence that Entamoeba histolytica infection of man represents a zoonoses. While animals, primates and dogs can be infected and show clinical symptoms, human disease is primarily associated with contamination of water and food by man (WHO 1979). Giardiasis (infection from Giardia lamblia) outbreaks are usually traceable to human contaminated water supplies, but recently some have been traced to contaminated water reservoirs of where epidemiological aspects indicate that wild animal infection may play a role (WHO 1979).

Environmental Factors Associated with Diarrhea

The hypotheses pertaining to environmental factors were tested for association with diarrheal incidence utilizing two statistical techniques. Nominal variables (water sources used and presence of fecal parasites) were tested for association with the Pearson's chi square statistic, while the other environmental factors were tested for significant association by regression analysis. A 0.05 alpha level was utilized as the measure of significance.

Table 12. Frequency of fecal parasites and age of the research sample.

Age (Years)	Parasitic Agents					
	Ascaris lumbricoides		*Entamoeba histolytica*		*Giardia lamblia*	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
0	2	1.21	4	2.42	0	0
1- 4	8	4.85	16	9.70	0	0
5-14	18	10.91	44	26.67	5	3.03
15-24	7	4.24	13	7.88	0	0
25-34	3	1.82	15	9.10	2	1.21
35-44	7	4.24	16	9.70	1	0.61
45-54	2	1.21	2	1.21	0	0
55-64	4	2.42	6	3.63	1	0.61
65-74	1	0.61	2	1.21	0	0
75 and up	1	0.61	3	1.82	0	0
Total	53	22.11	121	73.33	9	5.45

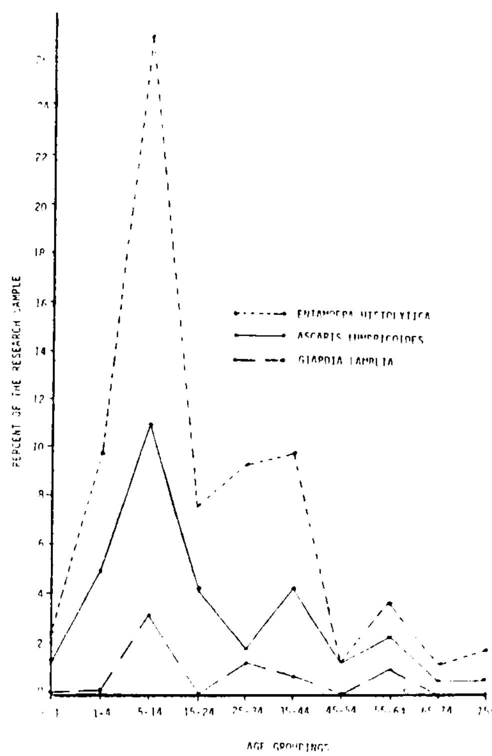


Figure 9. Percentages of parasites in the research sample according to age groupings.

Table 13. Fecal parasites* in tested animals**.

Animal	Microscopic Findings (Parasitic)
Burro	_Ascaris lumbricoides_
Cow/Ox	_Ascaris lumbricoides_
	Unidentifiable worm
Chicken/Turkey	_Ascaris lumbricoides_
Dog	_Ascaris lumbricoides_
	Entamoeba histolytica
Pig	_Ascaris lumbricoides_
	Entamoeba histolytica
	Giardia lamblia
Sheep	_Ascaris lumbricoides_
	Unidentifiable worm

*Identification of parasites of possible human importance.

**Listing of parasites found does not represent a single animal. At least 15 fecal specimens for each animal grouping were examined.

All nominal variables were tested for possible association with a categorical version of diarrheal incidence as expressed in the data analysis section of this chapter. Neither water source: faucet (0.105, 3, 0.9912), spring (1.704, 3, 0.6361), and river (2.592, 3, 0.4589) or presence of fecal parasites: Ascaris lumbricoides (1.375, 3, 0.7114), Entamoeba histolytica (2.567, 3, 0.4633) and Giardia lamblia (3.270, 3, 0.3518) demonstrated a significant association with diarrheal incidence when tested with the chi square statistic.

The lack of association between diarrheal incidence and water sources or presence of fecal parasites parallels the findings of research in other water projects (Winbald et al. 1980). Bomba (1982: 323) in working in Malawi in the Ministry of Health has stated:

> that there are no shortcuts to the improvement of public health in developing countries and that effective improvement can only arise through satisfactory systems of water supply, sanitation, and health education.

The remaining environmental factors (excluding nominal) were tested for significant association with diarrheal incidence. In total 11 environmental factors were statistically tested covering the living conditions (number of rooms and persons living in home), immediate environmental area (number and type of animals present), and the cooking/heating area (number of trips for wood per month, number of hours the fire burns). Of the 11 environmental factors tested only five were demonstrated with a F statistic to be significant at the 0.05 alpha level, while an additional variable was found to be significant at the 0.10 alpha level. These factors represented the living conditions and the immediate environmental area.

The living condition area variable found to be associated with diarrheal incidence was that of number of rooms in the home (F=16.70, 1, 0.0001). This factor is the only environmental factor found to have a positive slope (+0.42) for the single regression model. The mean number of rooms for participants was 1.02 with the majority of the "older" homes in the village being one room and the more "recent" homes consisting of more than one room. The more "recent" homes are being built by families with young children. These families have a greater likelihood of more diarrheal episodes than do homes with older individuals.

The immediate environmental area of the home is the grazing and storage area for all the animals the family possess. Three animal types and numbers were found to be negatively associated with diarrheal incidence at the 0.05 alpha level. The animals were: ox (F=4.42, 1, 0.0370), pigs (F=4.72, 1, 0.0312), chicken and turkeys (F=5.26, 1, 0.0230), and a summary variable reflecting total animal possessions of the family (number of ox + pigs + chickens or turkeys + dogs + burro). The possession of dogs (F=3.27, 1, 0.0725) also was found to be negatively associated with diarrheal incidence. The finding that as diarrheal incidence decreases the number of animals increased appeared to be contrary to the germ-theory basis of disease. As the density of animals increased, the environmental pollution would increase, thus increasing the likelihood of agent and recipient coming into contact and causing a diarrheal episode.

What may be occurring in the village is the combination of two mechanisms which decreases the diarrheal incidence as the number of animals increase. In a subsistence agriculture economy, animals (work and food) reflect the family's economic standing. As the number of animals increase, the economic level of the family increases, and although these animals may not be utilized to their "true" economic potential, they represent possible economic bargaining chips for the future. As the family gains more and more animals, they may be becoming more "educated" as to the possibility of environmental pollution, and with more animals, they may also be acquiring more land (on which to graze and store these animals) through the edijo system.

If more land is not available for animals and these animals are subsisting on marginal diets, perhaps these animals are acting as "scavengers" which may be "cleaning" up the environment by conserving and/or recycling all possible nutrient material. This "scavenger" type of behavior has been observed in all village animals on which data were collected. The animal ate whatever was available at the time whether it was its own fecal matter, human fecal matter, or any other item that might have some nutrient value. Nothing was declined as a possible nutrient source.

The increase in animal numbers and the decrease in diarrheal incidence could be due to both of the observed mechanisms or combination of factors. Further research is necessary to ascertain what other factors may also be interacting with this observation.

The final statistical analysis for the environmental factors was to obtain a regression model which best fits the variation in diarrheal incidence. All possible environmental factors were included in a Stepwise Regression Model for forward and backward elimination, and maximum r-square values. The total number of factors entered was 18 with seven nominal variables, six of which have already been covered previously and the seventh was a summary variable of parasitic load (summation of the number of parasites, each equal to one, present) and all of the remaining 11 environmental variables. With the alpha level remaining at 0.05, the best fit model for diarrheal incidence and environmental factors (Table 14) was the combination of number of rooms, presence or absence of Entamoeba histolytica, and the total number of animals owned by the participant's family (F=10.23, 3, 0.0001).

The low r-square value of the model (accounts for 16% of the variation in diarrheal incidence) may be because this research is attempting to associate what has happened in the past 15 to 17 years (reported diarrheal incidence) with factors that are observed in the present (number and type of animals present, number of trips for wood per month, and number of hours the fire burns). Several other considerations may account for the lack of predictability in the model. One or more explanatory variables may have been omitted from this study or there may be a randomized component of diarrheal incidence which is not recoverable from the error term. The high association between room number and diarrheal incidence may be due to the fact that the number of rooms has changed very slightly over the last 15 to 17 years while the other environmental factors may

Table 14. Total environmental model.

Source	DF	Sum of Squares	Mean Squares	F	Prob>F
Regression	3	4.29504868	1.43168289	10.23	0.0001
Error	161	22.52865072	0.13992951		
Total	164	26.82369939			

have changed at a far greater pace and do not reflect conditions as they have been in the past.

Implications

This attempt to ascertain the relationship between diarrheal incidence over the past 15 to 17 years and environmental factors has yielded unexpected insight into the actual cultural mechanisms which may be operating in the village of Santa Cruz Mixtepec. In a subsistence economy, the economic potential of animal ownership elevates the family as the number or type of animals increase. These animals are used for their potential economic value in immediate or future bargaining sessions. As the number or type of animals increase, the economic "wealth" increases, thus accounting for the observed association between the increase in animal number or types and the decrease in diarrheal incidence. These findings of the increase in economic standing and "wealth" due to animal number or type have been observed previously.

There are two possible observations made in the village which have not previously been mentioned in the literature. The observation of the traditional water vessels whose shape decreases the surface area exposed to contamination and the observation of the "scavenger" instinct of animals on marginal diets. Both of these observations may be unique to this village and thus will serve as information for the diarrheal control educational project.

The attempt to develop an environmental model yielded information which will provide baseline data for implementation of educational campaigns. The lack of association between past and present day factors demonstrates that this study is dealing with an evolving and dynamic cultural system even though located in an isolated geographical region.

CHAPTER V

SOCIO-CULTURAL FACTORS ASSOCIATED WITH DIARRHEA

Review of Literature

What may be viewed as disease or what may cause illness and possible treatment is defined by each cultural group (Foster 1974). This knowledge of disease is transmitted through cultural processes to members of the particular population. The caretaker of the ill, usually the women (mother and/or wife), treats the illness within the cultural precepts of the society. Due to the presence of socio-cultural beliefs and practices, maternal beliefs and practices associated with diarrhea often clash with modern medicine's diarrheal disease concepts (Gupte and Sasan 1983).

Diarrheal Causation

In a report of 600 case studies in Jammu, located in the Simla hills in India, Gupte and Susan (1983) found that 15% of the respondents did not understand the nature of diarrhea, while approximately half blamed "heat," "cold," "rains," "worms," and "faulty feeding" of the mother if the infant is breast-fed. Almost 10% of the mothers regarded diarrhea as the "curse of the devil."

Approximately 2% of the women in Santa Cruz, a suburb of Panjai, Goa, India, attributed the cause of diarrheal disease to infection or dirty environment, 17% attributed diarrhea to a change of food or indigestion, 10.3% believed eating of mud or sweets caused diarrhea, 24% blamed teething, 3.3% believed mother's food/habits caused diarrhea, 25.5% blamed it on worm infestation, 9.2% blamed superstition such as casting evil eye upon the child by someone out of jealousy or ill will or the child seeing a tree for the first time as responsible, and 8.5% related it to a cold climate. No one mentioned malnutrition as a cause of diarrhea (Srinivasa and Afonso 1983). Srinivasa (1977) reported that in areas of Pondicherry, India, 81% of villagers studied also attributed diarrhea to bad food habits or the disruption of the binary system (hot and cold) of food consumption.

Kumar et al. (1981) in interviews in another study in India found that mothers considered a causal relationship of diarrhea to excessive body heat, and therefore intake of "hot" foods like milk, mangoes, meat, eggs, dals (pulses), and jaggery were taboo. Reports from Kenya (Maina 1979) and Laos (Lishnevsky 1977) have stressed the importance of assessing food beliefs related to diarrhea.

Diarrhea Treatment

Treatment of diarrhea depends upon the categorization of diarrhea within the cultural realm (Foster 1974). Srinivasa and Afonso (1983) in interviews with mothers in a suburb of Panjai, Goa, India, found that 77% reported that they would first try a home remedy, 19% preferred to go either to the health center, hospital or a general practitioner, and 4% opted for Ayurvedic treatment. The home remedies mentioned were oral administration of "bitter medicine" (diluted infusion of certain leaves or roots), tying onion or garlic around the abdomen (33%), boiled rice water given orally and application of fomentation to the abdomen (5%), warm fenni with sugar given orally (2%), and application of fenni over the abdomen (0.8%). Kumar et al. (1982) also found that half of all mothers in their study believed in trying home remedies as a first step in treatment of diarrhea.

Vermeer and Ferrell (1985) have found that inhabitants of the village of Uzalla, Nigeria, ascribe anti-diarrheal properties to clay and they utilize it in traditional medicinal preparations to counteract diarrheal or intestinal problems. When samples of this clay were subjected to mineralogical analyses, there was a similarity between the Uzalla village clay and clay in the commercial pharmaceutical preparation, Kaopectate.

Research Hypothesis and Methodology

Research Hypothesis

Documentation of socio-cultural beliefs and practices associated with diarrhea necessitated the use of several data collection methods. The proposed hypothesis to be tested was:

There is no significant difference in whether participants wash their hands or not and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

Data Collection

Various methods of data collection were utilized to collect information on socio-cultural beliefs and practices and to substantiate information that had been collected. Interviews were conducted to obtain information pertaining to beliefs regarding diarrheal causation and treatment practices utilizing the interview schedule (Appendix C). Participants (female--food preparers) were interviewed to ascertain their practices regarding hand washing and food preparation. These were then checked with the key informant (director of the medical clinic). Observations and participant observation by the researcher also were used to verify the interview.

Data Analysis

Pearson's chi square statistic was utilized to test whether the hand washing and food preparers' practices were associated with diarrheal incidence. Information regarding beliefs associated with diarrheal causation were gathered to ascertain the current status of information regarding this illness.

Results and Discussion

Hand Washing and Food Preparer's Practices

The practices of hand washing prior to food consumption, food preparation, and following defecation were not associated with diarrheal incidence. Information gathered pertaining to these practices was in the form of negative and positive answers. The possibility of ascertaining more definitive information was not practical. The information collected was in response to what the participant believed the interviewer wanted to hear rather than a true reflection of the actual practice. This fact was further substantiated by the key informant, who disputed that the majority of the villagers washed their hands prior to performing any of the acts listed above.

Beliefs Associated with Diarrhea

The folk perspective of illness prognosis in the village of Santa Cruz Mixtepec is defined as (1) strong sickness (cuehe ntsitsa), and (2) thin sickness (cuehe yaxi). Strong sicknesses are categorized due to their (a) mortality rate, (b) affect of divining, and (c) availability of herbal remedies. All occurrences of diarrhea are considered to be strong sicknesses (cuehe ntsitsa). The villagers have classified diarrhea into four types. Each type of diarrhea is related to some macroscopic observation. However, only one type of diarrhea was considered to necessitate a healer from the onset of the symptoms. The other three types of diarrhea are controlled by home remedies until factors arise that may or may not indicate the necessity of a healer (Ibach 1985).

Disease Causation and Treatment

Common knowledge of herbal remedies and their uses are prevalent throughout the community. Symptoms are generally related to calendrical factors (which necessitate the use of a healer), or the non-calendrical factors that may be treated by home remedies. The spectrum of illnesses that a community member can treat by home remedies was not controlled by the prognostic category of the illness or disease classification (strong and thin) but by whether or not the symptoms indicated a non-calendrical factor that does not necessitate the services of a healer.

Herbal home remedies are used by the patient or the patient's relatives to affect the cure of illness. The herbal home remedies are chosen relative to the calendrical and non-calendrical factors of illness cure. The symptoms are categorized as to their "hot" or "cold" qualities; and the appropriate herbal remedies and diet prescription are selected to counteract the thermal qualities of the illness (Appendix G). These remedies (herbal and dietary) are administered with the prognosis that, through immediate action, further complications due to non-calendrical factors may be avoided.

In the event of simple diarrhea in an infant, the color of the stool determines the remedy selected (Table 15). If the diarrhea was green, the herb of the morning (<u>yucu nduu</u>) was selected because it was believed that the diarrhea was due to the warm time sickness. The cold herb (herb of the morning) and cold foods and beverages were given to the patients and all hot foods are withheld.

The treatment for yellow diarrhea consisted of giving coffee without sugar to the infants. Yellow diarrhea was believed to be due to a cold condition of the stomach; therefore, the remedy must be hot or refreshing. All cold foods and beverages are withheld, and only hot foods and beverages are given as part of the remedy. If during the treatment for diarrhea, the stool became milky (contains mucus), the course of action was to administer buzzard herb (<u>yucu lochi</u>) because milky (mucus) diarrhea (<u>cuun xicui</u>) indicated that

Table 15. Home remedy diarrheal treatment strategies for Santa Cruz Mixtepec.

Diarrhea (Color)	Source of Illness	Treatment
Green	Warm time sickness	- *yucu nduu* (Herb of the Morning) - encourage intake of cold foods and beverages - discourage intake of hot foods and beverages
Yellow	Cold condition of stomach	- encourage intake of hot and refreshing foods and beverages
Milky	*Mal de ojo* (evil eye)	- *yucu lochi* (buzzard herb)
Bloody	*tachi xeen* (demon) *tach ucu* (devil of the mountain)	- necessitates the use of a healer

the infant has come under the influence of the evil eye. Hence, any color change in the stool indicates the necessity for a change in the diarrheal remedial strategy.

If blood appears in the stool during treatment of diarrhea, regardless of the color (past and/or present) of the stool, the remedial strategy changes from one in which home remedies are possible to one that needs the use of a healer so that a cure can be affected. Bloody sickness or bloody diarrhea (cuehe nii) indicates the intrusion of demon (tachi xeen), or devil of the mountain (tach ucu).

Interestingly, the recommended clinical laboratory procedure for stool examination involves making observations and notations on the color of the specimen and presence of blood and mucus. This gross examination of the feces aids the physician in the appropriate diagnosis (Lennette et al. 1974). The division of diarrheal agents based upon these macroscopic stool characteristics (color, mucus, and blood) (Table 16) parallels the basis for the participant's diarrheal treatment strategy (Table 15).

Participants interviewed had diverse opinions on what caused diarrhea (Table 17). These opinions ranged from "I have no idea" to "the disruption of calendrical forces." The question was phrased simplistically as "what causes diarrhea?" with no further specification. Confusion surrounding whether the question pertained to yellow or green diarrhea may be the reason for the absence of a definitive answer.

Table 16. Routine macroscopic observations for fecal specimens.*

Macroscopic Characteristics	Diarrheal Causative Agents			
	1	2	3	4
Consistency	Watery	Loose	Loose	Watery
Color	Yellow-Green	Green	Green	--
Blood	Common	Rare	Rare	Always
Mucus	Present	Variable	Variable	Always

*Modified from Nelson and Haltalin (1971) and Miller (1984).

1 *Shigella*

2 Enteropathogenic *Escherichia coli*

3 *Salmonella* excluding typhoid

4 *Entamoeba histolytica*

Table 17. Primary cause of diarrhea.*

Primary Cause	Frequency	Percent
Cold Condition of the Stomach	20	29.41
Disruption of Calendrical Forces	16	23.53
Have No Idea (Do Not Know)	14	20.59
Warm Time Sickness	18	26.47
Total	68*	~100.00

*Responses are from participants 18 years old and older.

There was also no definitive agreement on the type of diarrheal treatment to administer, perhaps due to lack of clarity for the simplistic question, "What do you do to treat diarrhea?" (Table 18).

Table 18. Primary suggested diarrheal treatment.*

Primary Diarrheal Treatment	Frequency	Percent
Buzzard Herb	17	25.00
Come to the Clinic	4	5.88
Herb of the Morning	16	23.53
No Cold Foods	13	19.12
No Hot Foods	18	26.47
Total	68*	100.00

*Responses are from participants 18 years old and older.

Implications

Hand washing practices are not prevalent in the village of Santa Cruz Mixtepec. The failure of this practice facilitates the spread of those diarrheal causative agents which are present in the soil, water, fecal matter, and food preparation material. In parts of Mexico, there are traditional beliefs which caution people against washing their hands at certain times, primarily when their hands are viewed as "hot." "Hot" hands require time to return to normal temperatures. If they are chilled by water (a "cold" substance) while still hot, the person will experience rheumatic pains or arm cramps. Hence, cautious people who faithfully adhere to their cultural rules of preventative medicine wait an hour or more before washing their hands after performing certain activities. Frequently, a woman engaging in a "hand-heating" activity, uses the toilet and then, because she cannot wait an hour to wash her hands, turns directly to the preparation of a family meal (WHO 1984b).

The presence of a binary classification system may account for a portion of the absence of hand washing but an additional factor may be the importance that is placed on water in a culture in which the majority of persons are engaged in subsistence agriculture. Simplistic sanitation measures such as rinsing or washing of the metate, waxed circles, and hands prior to food preparation, and washing hands before meal consumption and following defecation may be viewed as a waste of water which could be better used for crop irrigation. The location of clean water sources are a distance away from both homes and fields so that washing hands is not a simple matter of going to the faucet.

Socio-cultural factors related to disease classification, treatment and prevention must be ascertained prior to the development and implementation of any educational program. Determining the beliefs regarding the disease and an evaluation of the degree to which these beliefs are held within the community will affect how they are utilized in any educational program.

CHAPTER VI

HEALTH FACTORS ASSOCIATED WITH DIARRHEA

Review of Literature

Malnourished children in developing countries have been found to have more bacteria in their gastro-intestinal tract than well nourished children. These bacteria are considered to be contributory factors to the diarrhea in these children (Gracey et al. 1973). The major determinant of malnutrition in Bolivian children was found to be gastro-intestinal infection. Diarrhea was found to be as important as an inadequate diet in causing malnutrition (Anderson 1981).

Donoso (1979) and Rhode (1979) found interaction of malnutrition and infection to work in two ways. The malnourished child was more prone to diarrheal disease and the diarrhea contributes to malnutrition, either through malabsorption or lower food intake. Secondly, basic poverty, ignorance and non-hygienic conditions offer high risk of infection to the child beginning to eat solid foods.

Food Intake

Food intakes may interact with diarrheal disorders. Diarrhea, apathy (not being their usual self), and the presence of any of the following items: fever, vomiting, signs of rash or any indication of communicable disease, and being so ill as to be confined to bed in preschool children of rural Guatemala were associated with an average reduction in daily food intakes of nearly 20%, equivalent to 175 kcal and 4.8 grams of protein. There was a lower dietary reduction effect (61 kcal and 1 gram of protein) for respiratory infections (Martorell et al. 1980).

Breast feeding was identified as the greatest single factor that contributes to the survival of most African children; however, it was found that at the time of weaning, foods are often insufficient to support normal growth (Kazimi and Kazimi 1979). While Watkinson (1981) reported that 66% of breast fed African infants had diarrhea before the introduction of other foods, it was generally mild and only 12% of the infants suffered diarrhea induced weight loss during the preweaning period. The bulk of diarrhea morbidity occurred after weaning had started and children with the higher breast milk intakes tended to be older before losing weight with diarrhea than children with lower breast milk intake.

Infection

A cohort of 45 children from birth to three years of age in their natural ecosystem were examined retrospectively by Mata et al. (1983) to determine patterns of infection, morbidity, and growth. Rotavirus infections were found to be uncommon in the first month of life in intensively breast-fed infants. Infections increased with age to reach a maximal rate in the 6 to 18 month age child. While there was a high incidence of diarrhea in the cohort, rotavirus was associated with only 10% of such episodes and the serious outbreak of rotavirus generally occurred during the dry season (September through December). Infants and young children with better than average growth in a Belize study were those who were less frequently exposed to numerous infectious and nutritional stresses (Jenkins 1980).

Anthropometric Parameters

Information from medical charts of 109 infants who were younger than 9 months of age and who had been hospitalized with acute diarrheal syndrome in 1978 were compared with data from medical charts of 108 healthy infants of the same age range, sex, and ethnic distribution who were attending a well-child clinic serving the same geographical area. In this comparison, 45.3% of the acute diarrheal syndrome patients and 11.3% of the well children were below the 10th percentile in weight. When height percentiles were compared, 41.8% of the acute diarrheal syndrome patients and 15.3% of the well children were below the 10th percentile (Jaili et al. 1982).

Quantification of the relationship between nutritional status and diarrheal disease was reported in a 1 week study period of children in El Salvador by Stetler and his colleagues (1981). Strong associations were observed between reported diarrhea and combined wasting (defined by low weight for height) and stunting (defined by low height for age). These associations held for all age groups studied. Significant association was reported between diarrhea and wasting alone, low weight for age, and low arm circumference. No consistent association was observed between reported diarrhea and stunting (defined by low height for age) suggesting that short stature was not, by itself, a risk factor for diarrhea.

Research Hypotheses and Methodology

The documentation of the possible relationship of health status indicators and diarrheal episodes or diarrheal incidence necessitated the utilization of several different procedures to test the following hypotheses:

1. There is no significant difference between weight attainment in children, as measured by the Gomez scale, and diarrheal incidence (total number of diarrhea episodes/years since first reported diarrheal episode).

2. There is no significant difference between height attainment in children, as measured by stunting (<90% of reference standard), and diarrheal incidence (total number of diarrhea episodes/years since first reported diarrheal episode).

3. There is no significant difference between the weight for height parameter in children, as measured by wasting (<80% of reference standard), and diarrheal incidence (total number of diarrhea episodes/years since first reported diarrheal episode).

4. There is no significant difference between upper-arm circumference and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

5. There is no significant difference between triceps skinfold/fatfold and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

6. There is no significant difference between mid-arm muscle circumference and the incidence of diarrhea (total number of diarrhea episodes/years since first reported diarrheal episode).

Data Collection

Three sources of information were utilized to ascertain whether the indicators of health status were associated with diarrheal incidence. The health clinic records were reviewed, in the same manner as for diarrheal episodes, to obtain information pertaining to the episodes of fever for each participant. Fever incidence was calculated, as with diarrheal incidence, by dividing the number of fever episodes by the number of years since the first reported fever episode.

The adult members of the participant's family were interviewed utilizing the health status section of the schedule in Appendix C. These questions pertained to the number and reason for visiting the clinic, food intake, and anthropometric measures.

Anthropometric procedures and measurements. The research study protocol was for five anthropometric measurements (weight, height, tricep skinfold, upper-arm circumference, and head circumference) to be taken on each participant. The anthropometric measurements were taken by the researcher, following the procedures below as recommended by the Committee on Nutritional Anthropometry (1956).

Weight. Weight was taken in bare feet and ordinary clothing, using a Health-o-Meter scale model 134 and recorded in pounds.

Height. Using an anthropometer, the height was taken with subjects standing erect in bare feet, heels together and head in the Frankfort Horizontal plane position. Stature was recorded to the nearest millimeter. Children approximately under the age of three were measured for length in a supine position on a "Baby Board" on loan from the University of Tennessee Department of Anthropology.

Upper-arm circumference. Upper-arm circumference was measured on the left arm. The midpoint of the upper left arm was located and marked while the subject's arm hung in a relaxed state, an insertion tape was placed around the arm at the marked mid-point. The tape was held firmly but gently to avoid compression of the soft tissue. This circumference was recorded to the nearest 0.1 centimeter (Jelliffe 1966; Zerfas 1975).

Tricep skinfold/fatfold. Following the procedure described by Tanner and Whitehouse (1962), the tricep skinfold/fatfold measurement was taken on the dorsum of the left arm at the previously marked mid-point between the acromial and the olecranum processes. Readings were made to the nearest 0.1 millimeters using a Lange Skinfold Caliper, calibrated to exert a pressure of 10 grams per cubic millimeter of jaw surface.

Head circumference. Head circumference was measured at the greatest prominence of the frontal and occipital bone with an insertion tape pulled sufficiently tight so as to compress the hair braids. Measurements were recorded to the nearest 0.1 centimeter (Jelliffee 1966).

<u>Food intake</u>. Each food preparer was interviewed twice (clinic and home setting) as to what and how much food they prepared for

their household/family each day. Information obtained in these two interviews was highly variable possibly because few of the food preparers were able to comprehend the importance of their answers. Frequently, the response to the amount and type of food prepared was that "it depends!" The only reliable food intake answer given was that of total number of tortillas (staa) prepared daily. An individual food consumption variable was obtained by dividing the total number of staa prepared by the number of persons residing in the household. Although this individual food consumption variable may not reflect the actual nutrient intake of participants, it does give an indication of average household consumption based on the assumption that all the food was divided evenly.

Data Analysis

Several analysis techniques were utilized to assess the health status indicators and their possible relationship with diarrheal episodes and/or diarrheal incidence.

Children. Prior to the actual testing of the hypotheses, children's growth measurements (stature for age, weight for age, and weight for stature) were compared to the recommended World Health Organization reference standard. The reference is that of the National Center for Health Statistics (NCHS) growth curves (United States Public Health Service 1976). The data for the NCHS growth curves birth to 36 months reference was collected from 1960 through 1975 from white middle class families living near Yellow Springs, Ohio (Hamill et al. 1977).

In addition, means were calculated for weight, stature, upper-arm circumference, and tricep skinfold/fatfold and these mean values were compared to other appropriate Amerindian children from the countries of Mexico (Tlaltizapan-Ortiz and Mora 1967; and Zapotec-Malina et al. 1972) and Guatemala (Maya-Mendez and Behrhost 1963; Sabharwal et al. 1966). Children's weight for age patterns were assessed to evaluate the degree of malnutrition using the Gomez scale. Nomograms developed by Dugdale (1984), using the NCHS data as the reference standard, were utilized to divide the children into the four levels of weight for age. This assessment of how far the actual participant's measurement deviated from the standard or reference set provides information pertaining to the possible abnormality of a subject (Waterlow et al. 1977).

The four levels of the Gomez scale (Gomez et al. 1955) are:

Normal — between 90 and 110% of reference value (50th centile of United States or other standards); 84% of the children in a healthy population are expected to fall in this category.

Grade I — below 90% to 75% of the reference value; 16% of healthy children are expected to fall into this grade.

Grade II — below 75% to 60% of reference value; no healthy children are expected to fall in this category; among those who do, however, many may be normal weight for height but stunted while others may be very thin or wasted reflecting recent weight loss.

Grade III below 60% of reference value; this indicates severe undernutrition, and, in case of an infant a life threatening situation, in the older children this grade includes those who have experienced recent excessive weight loss and those exhibiting nutritional dwarfing.

Children's height patterns were also assessed for stunting (<90% of expected height for age) (Waterlow and Rutishauer 1974). The Gomez scale and the stunting parameter were tested as to their possible association with diarrheal incidence utilizing the Pearson's chi square statistic and diarrheal incidence divided into categorical divisions as defined in Chapter IV.

Total research sample. All health indicator variables were tested for association with diarrheal incidence utilizing a single factor regression analysis. All of the health indicator variables were subjected to Stepwise Regression analysis to obtain a health indicator model which best accounts for the total variation in diarrheal incidence.

Results and Discussion

Prior to the ascertainment of the relationship between diarrheal incidence and indicators of health status, the children's anthropometric parameters were compared to the National Center for Health Statistic growth curves.

Comparison and Observations on Growth Parameters

Infants, birth to 36 months. Infants' weight (Figure 10) variables generally fall within the 95th and 5th centile prior to the first year of life. After this time, the values fall progressively below the 50th centile. This progressive decline of observed values can also be seen for the length of infants (Figure 11). Contrary to this trend, the weight for length graph (Figure 12) demonstrates that the children generally fall well within normal parameters for this growth variable which is one of the World Health Organization's recommended indicators of nutritional status (WHO 1976a) regardless the age of the child.

Children, 2 through 18 years. The majority of the children's weight (Figure 13) falls below the 50th centile of NCHS growth curves. Some children's, prior to the age of 9, weights fall within the 50th and 5th centile but following this age the children's weights fall progressively away from these centiles. Stature for age (Figure 14) demonstrates that few participants are close to the 50th centile of height attainment, those that are close to this centile are males and the majority of individuals fall below the 5th centile. The weight for stature parameter (Figure 15) for ages 2 through 10 years show the same trend that was seen in Figure 12 for participant's age birth through 36 months. The child participants are stunted in relation to U.S. standards for height and weight parameters.

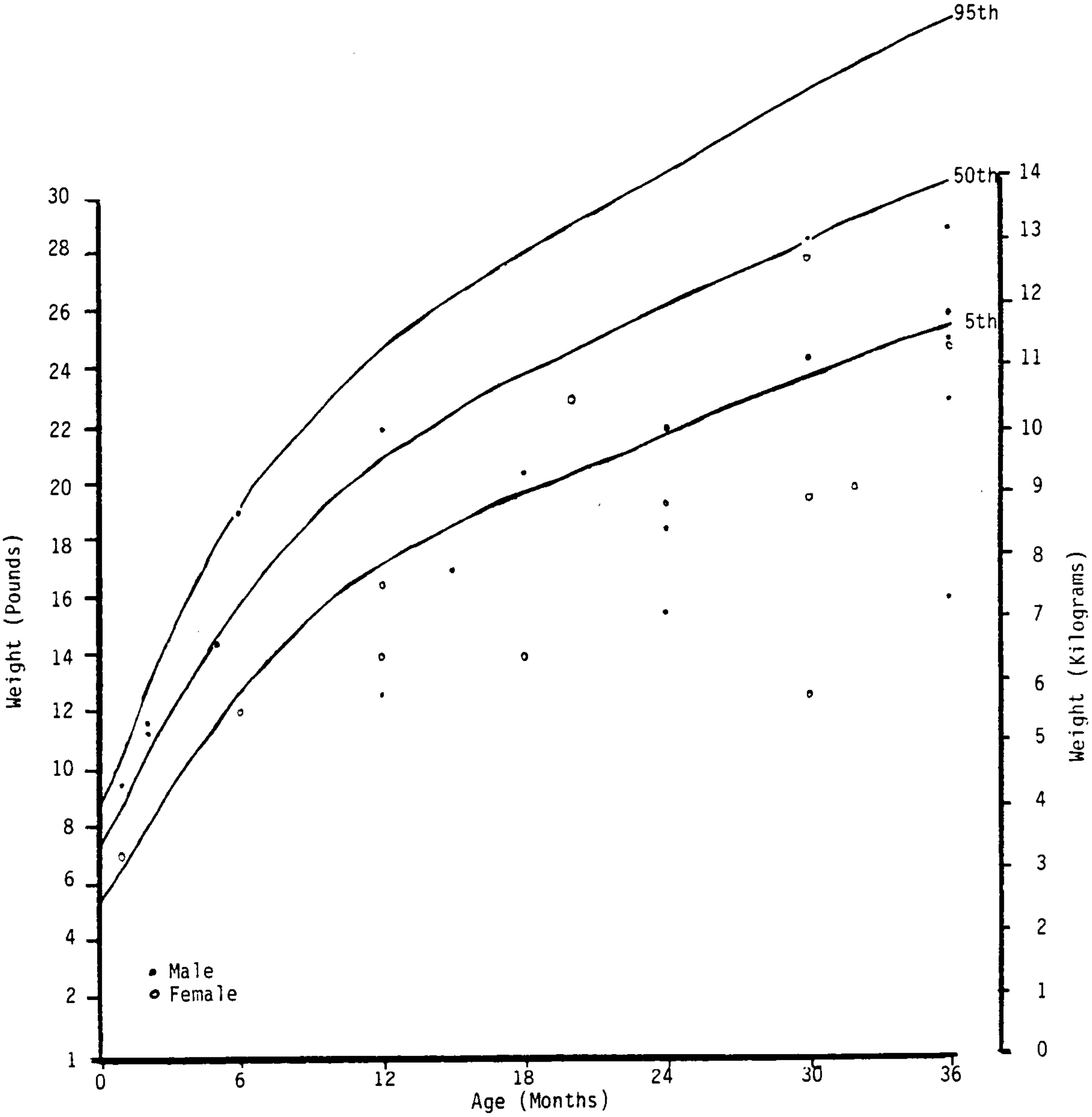


Figure 10. Participant's weight for age, birth through 36 months, compared to the growth curves of the National Center for Health Statistics.

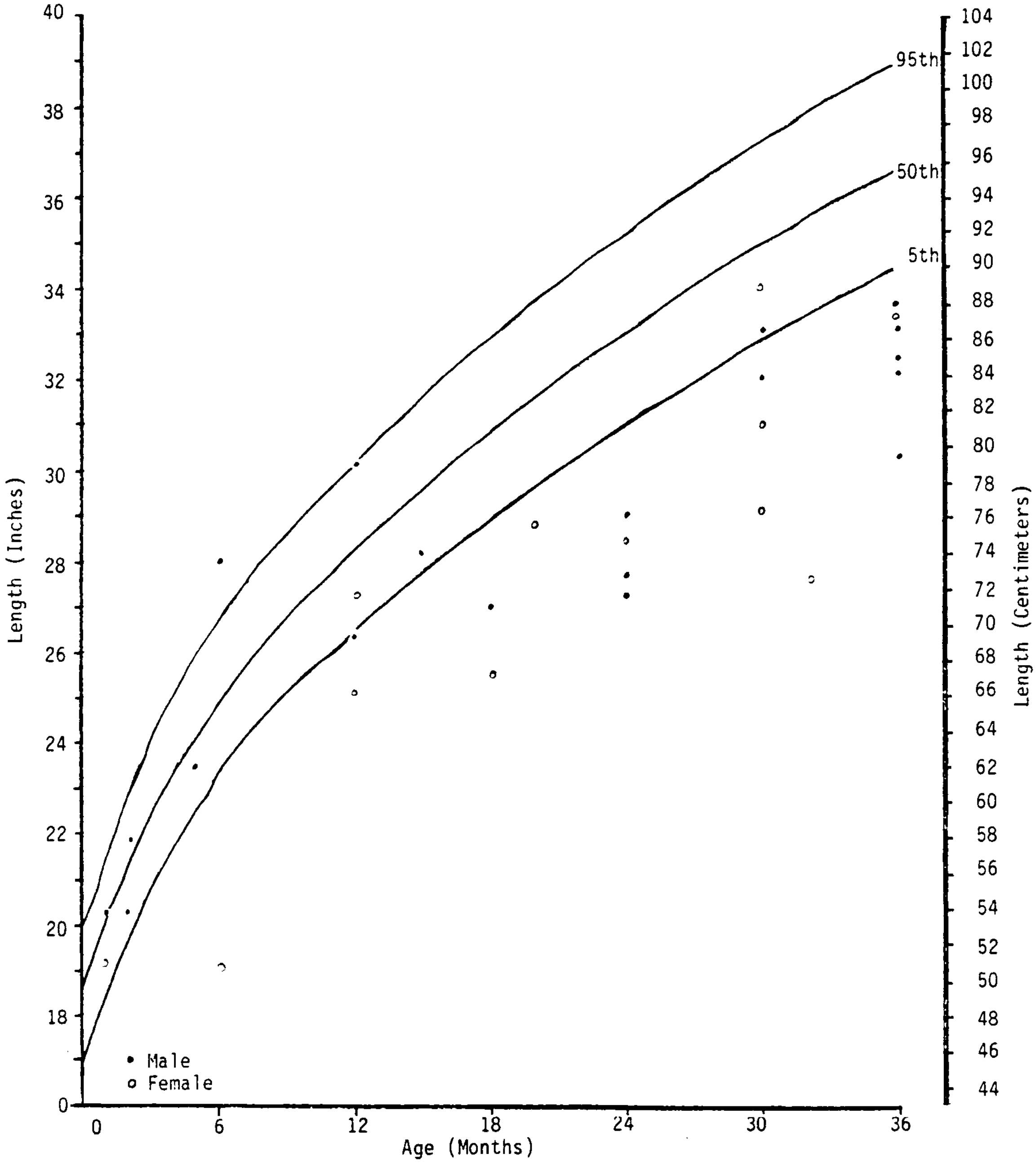


Figure 11. Participant's length for age, birth through 36 months, compared to the growth curves of the National Center for Health Statistics.

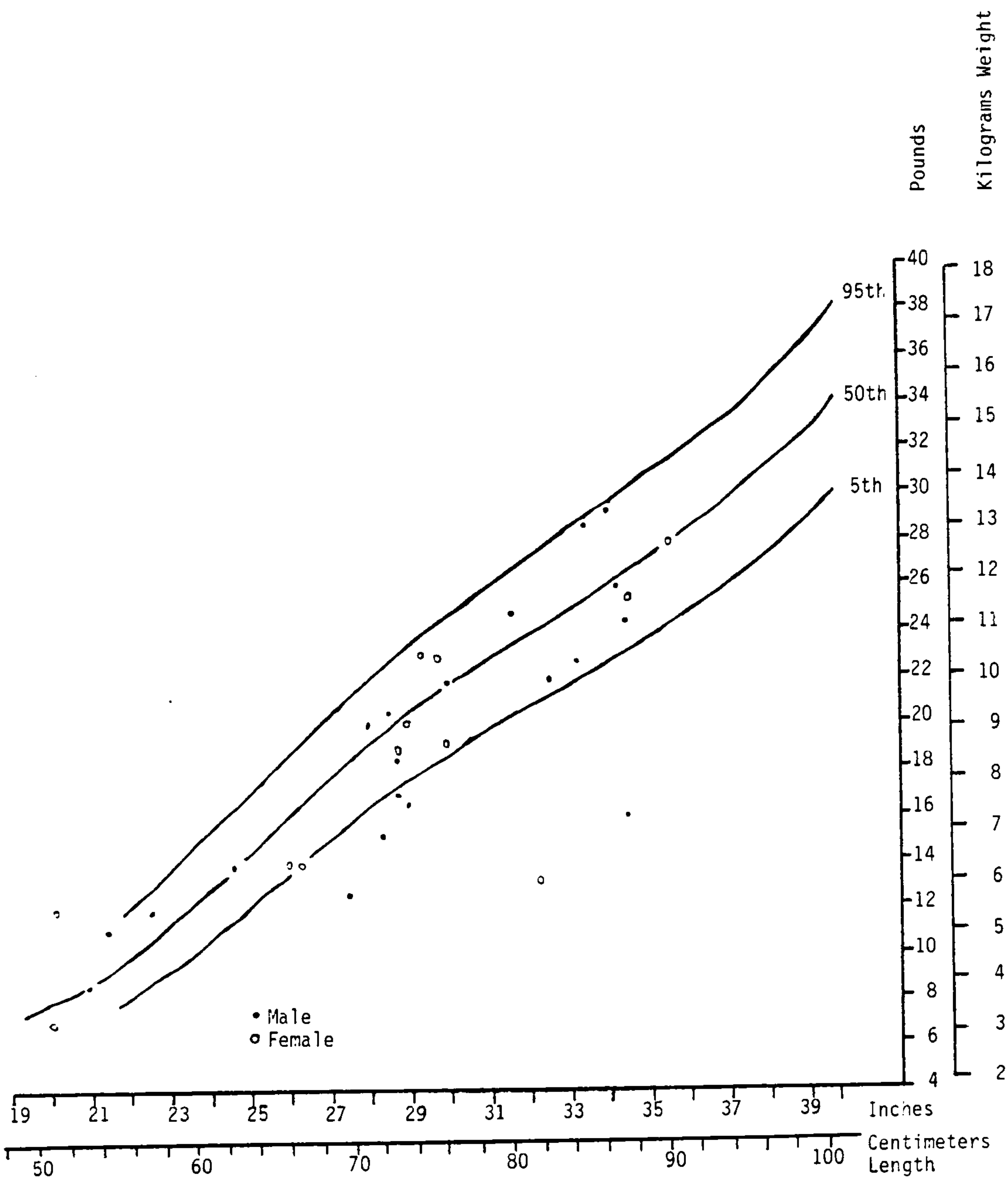


Figure 12. Participant's weight for length, birth through 36 months, compared to the growth curves of the National Center for Health Statistics.

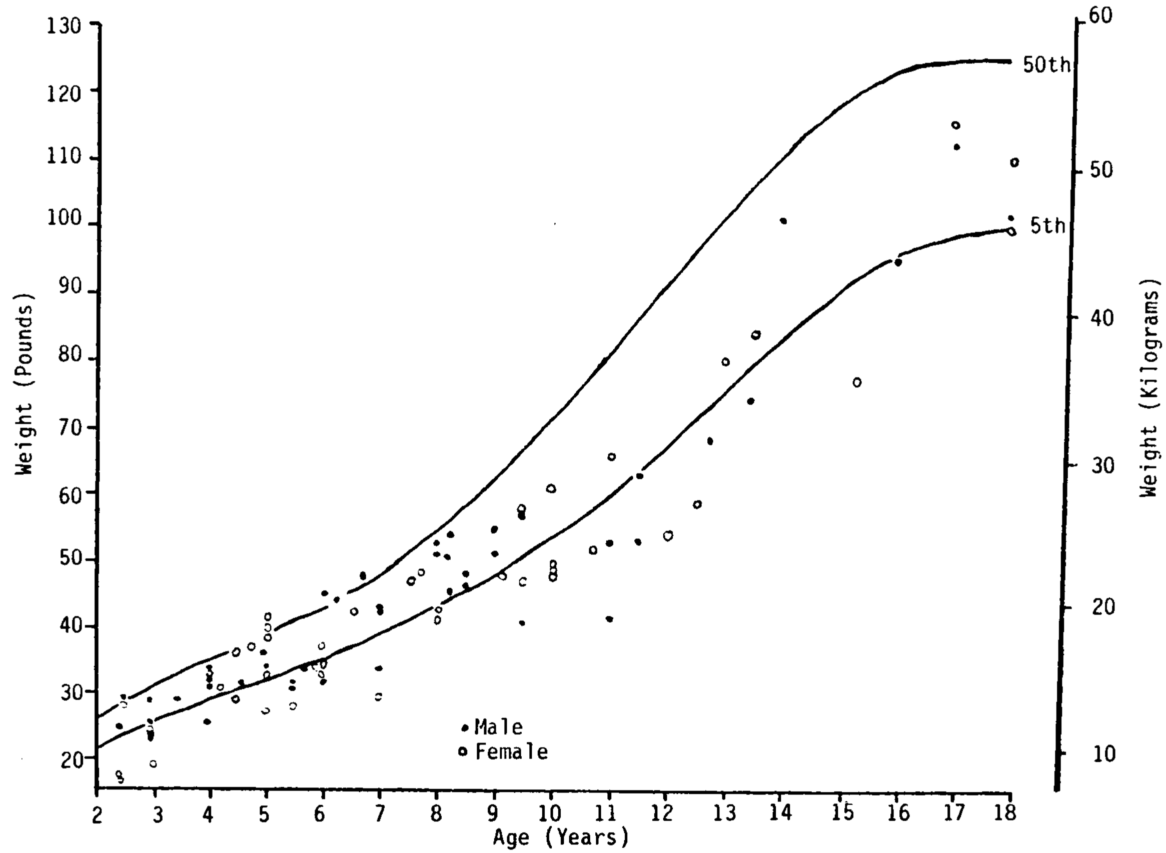


Figure 13. Participant's weight for age, 2 through 18 years, compared to the growth curves of the National Center for Health Statistics.

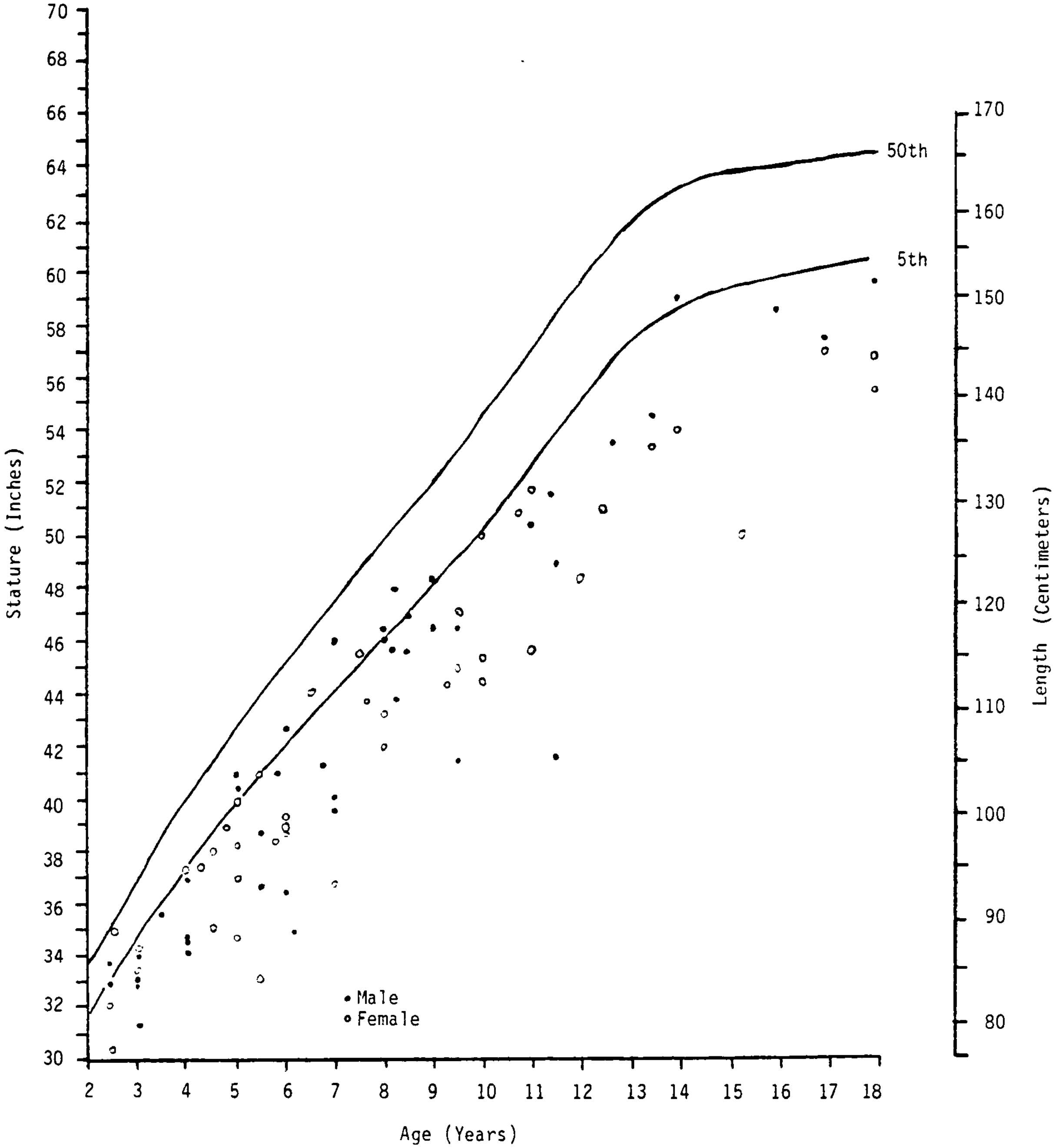


Figure 14. Participant's stature for age, 2 through 18 years, compared to the growth curves of the National Center for Health Statistics.

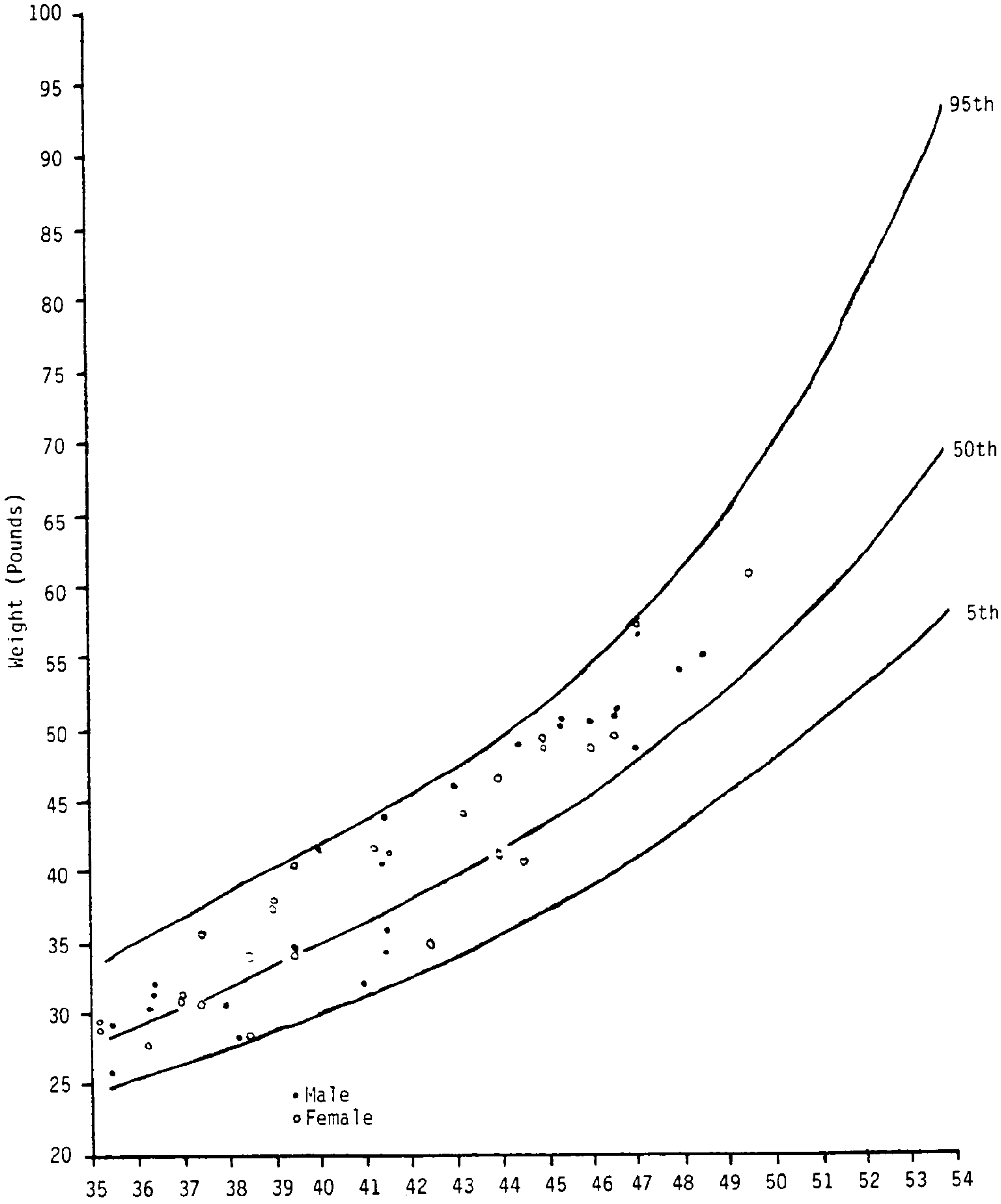


Figure 15. Participant's weight for stature, 2 through 10 years, compared to the growth curves of the National Center for Health Statistics.

The comparison of the NCHS growth curves to that of the growth of the research participants appears to place Mixtec children in and below the 5th centile, but the data from which these growth curves were derived were from middle class Caucasian children and does not include children from the same genetic and environmental conditions. The most meaningful growth parameter of the NCHS growth curves is that of the weight for stature since that gives an age independent assessment of nutritional status, but comparison with other more culturally and genetically appropriate growth studies may add more insight into the growth of children in the village of Santa Cruz Mixtepec.

Comparison to other appropriate Amerindian studies and international references. Mean values of anthropometric measurements (weight, stature, triceps skinfold/fatfold, and upper-arm circumference) on children from approximately ages 6 through 18 years are available from studies of Amerindian children in the countries of Mexico (Tlaltizapan-Ortiz and Mora 1967; and Zapotec-Malina et al. 1972) and Guatemala (Maya-Mendez and Behrhost 1963; Sabharwal et al. 1966). Mean values were obtained for all child age groupings (birth through 18 years) in the research study (Appendix H). Comparisons were made between the previously cited mean anthropometric values and the means obtained as a result of this research. Possible variations in this research study's plotted means may be due to the limited number of individuals in each of the age groups.

Mean weights. Mean female weight (Figure 16) demonstrates that although the Mixtec graph is highly variable after the age of 13, the mean values are all below that of any of the other anthropometric studies. While for the males (Figure 17), this trend is reverse since only once does a mean value fall below any of the other anthropometric studies.

Mean stature. In female's mean stature (Figure 18), the trend seen in the mean weight graph appears to again be true since the majority of the median height values of the research sample are below the other cited values. For males (Figure 19), the mean values begin below the other plotted means but by the age of 12 years, they have risen and are above both the Zapotec and Mayan values still approximately the last two plotted years (17 and 18 years of age).

Mean upper-arm circumference. In the female upper-arm circumference (Figure 20) graph all plotted means appear to be very close to each other with only a single exception where the Mixtec value falls below the other values at the age of 12. The male upper-arm circumference values (Figure 21) are more dispersed than are the female values, with the Mixtec values falling below the other means at the ages of 8, 9, and 10 after which the mean values rise to above those of the Tlaltizapan and Zapotec values.

Tricep skinfold/fatfold. The mean values of tricep skinfold/fatfold for females (Figure 22) and males (Figure 23) demonstrates a pattern that the Mixtec average values are variable but are nonetheless close to the other cited values.

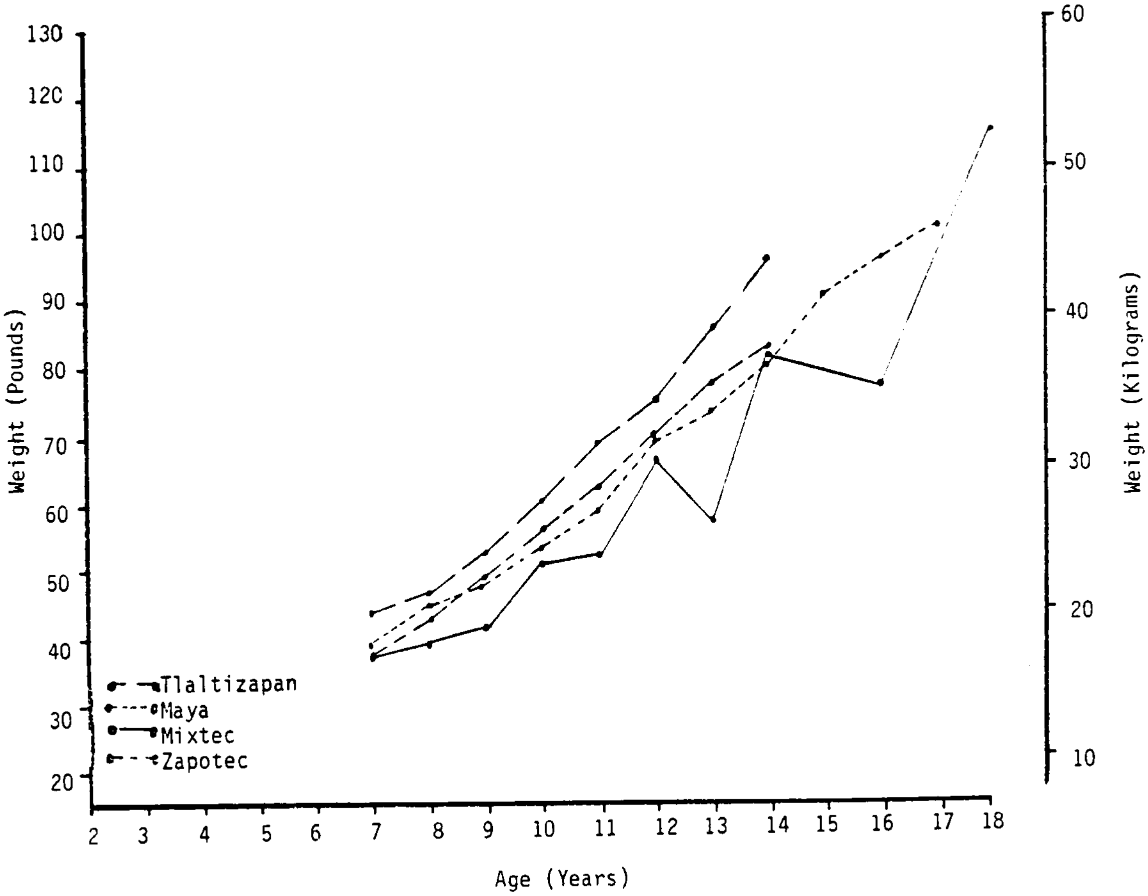


Figure 16. Mean female weight for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Sabharwal et al. 1966.
Tlaltizapan--Ortiz and Mora 1967.
Zapotec--Maline et al. 1972.

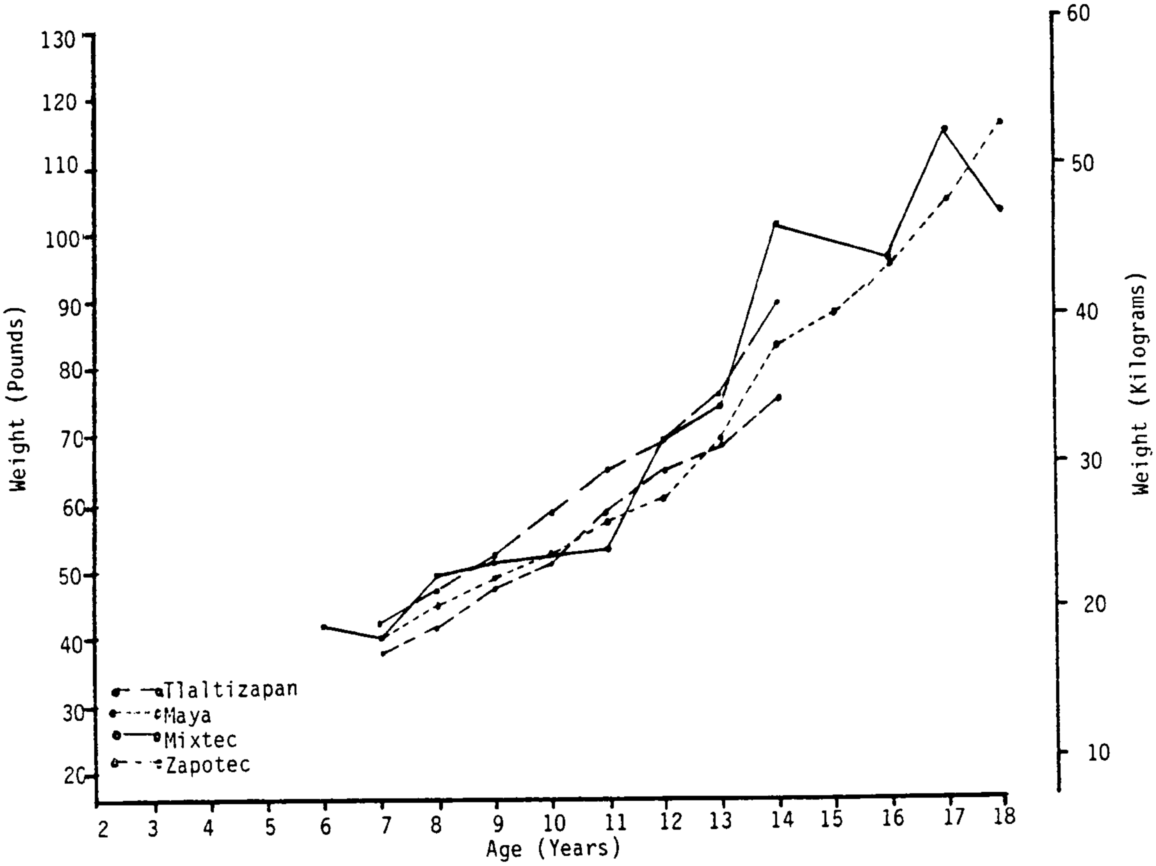


Figure 17. Mean male weight for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Mendez and Behrhost 1963.
Tlaltizapan--Ortiz and Mora 1967.
Zapotec--Malina et al. 1972.

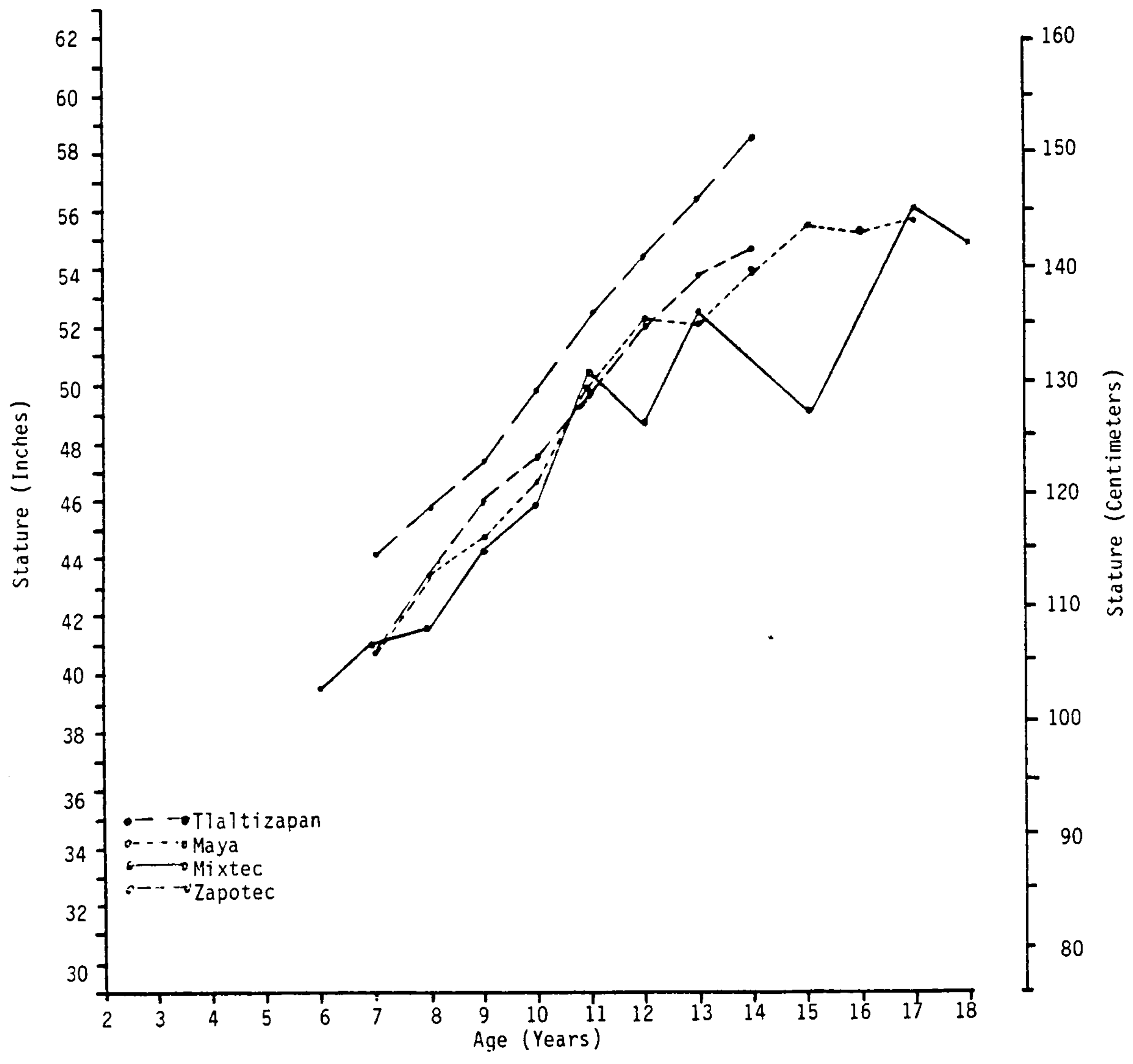


Figure 18. Mean female stature for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Sabharwal et al. 1966.
Tlaltizapan--Ortiz and Mora 1967.
Zapotec--Malina et al. 1972.

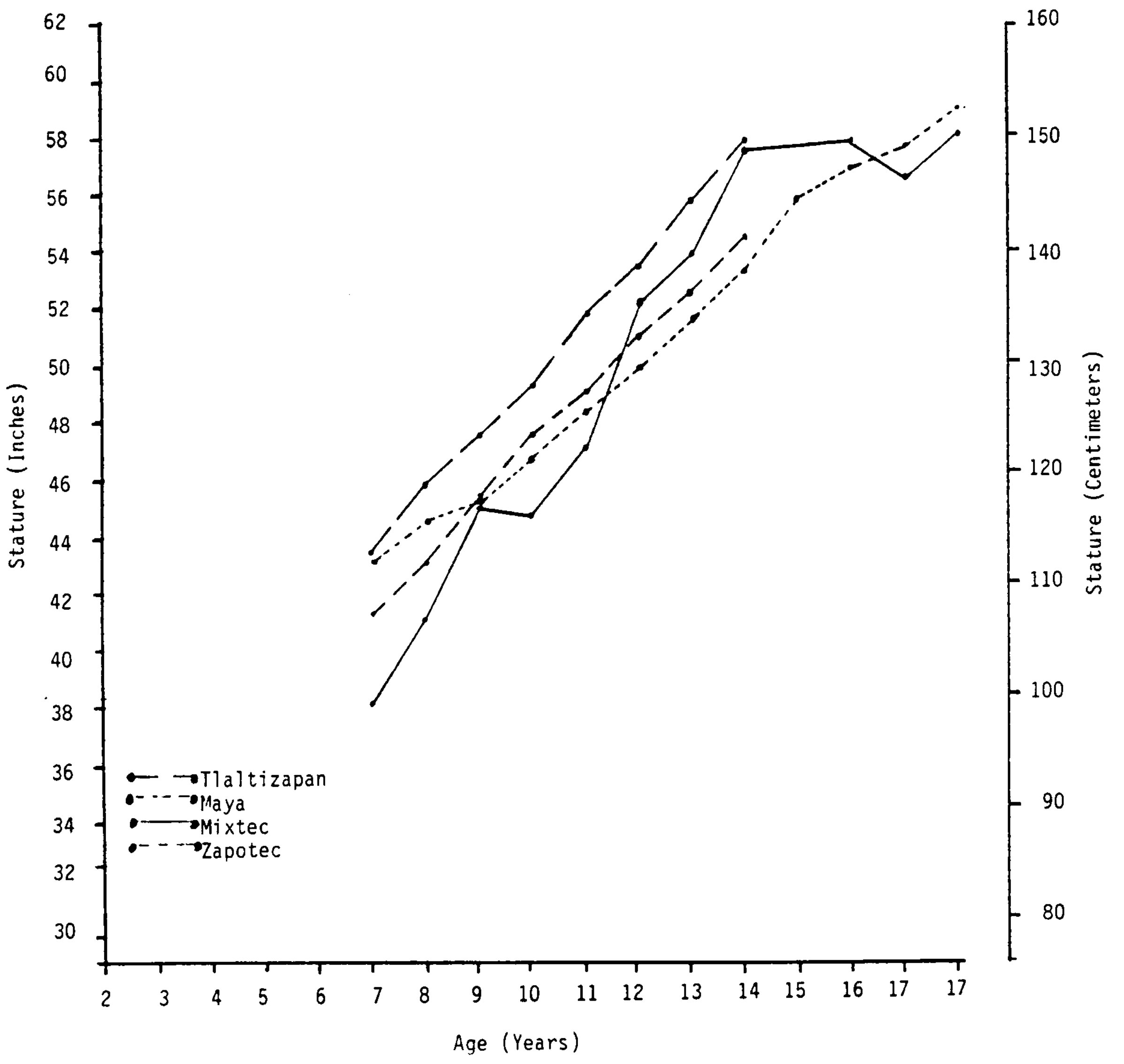


Figure 19. Mean male stature for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Mendez and Behrhost 1963.
Tlaltizapan--Ortiz and Mora 1967.
Zapotec--Malina et al. 1972.

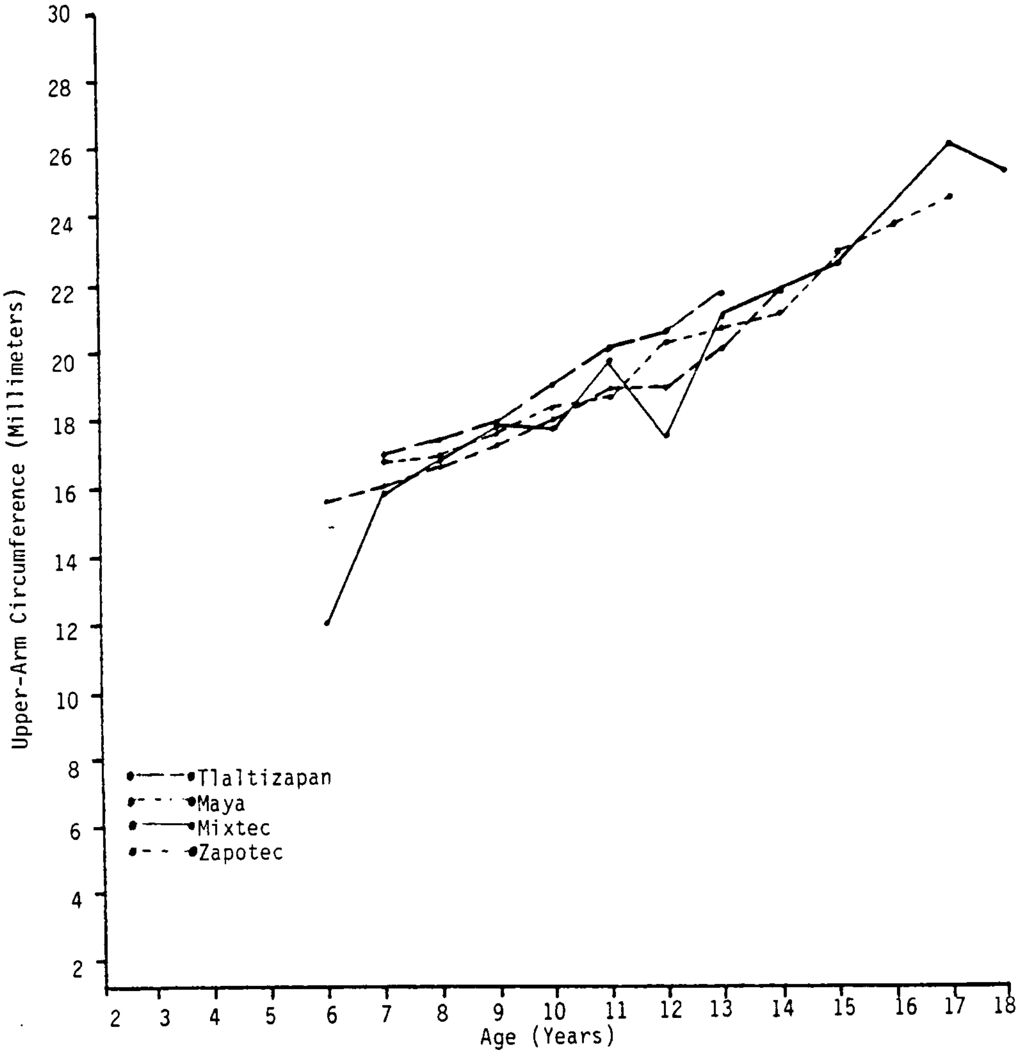


Figure 20. Mean female upper-arm circumference for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Sabharwal et al. 1966.
Tlaltizapan--Ortiz and Mora 1967.
Zapotec--Malina et al. 1972.

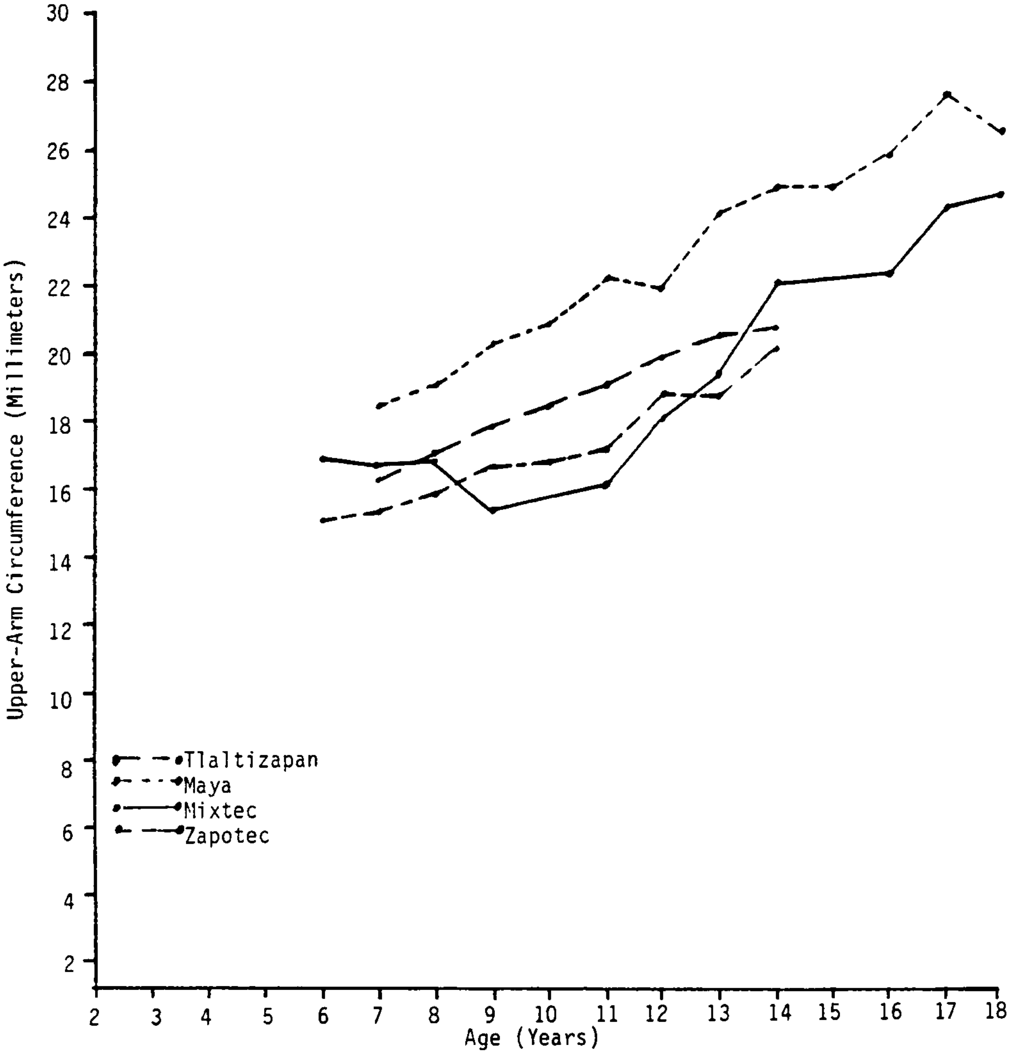


Figure 21. Mean male upper-arm circumference for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Mendez and Behrhost 1963.
Tlaltizapan--Ortiz and Mora 1967.
Zapotec--Malina et al. 1972.

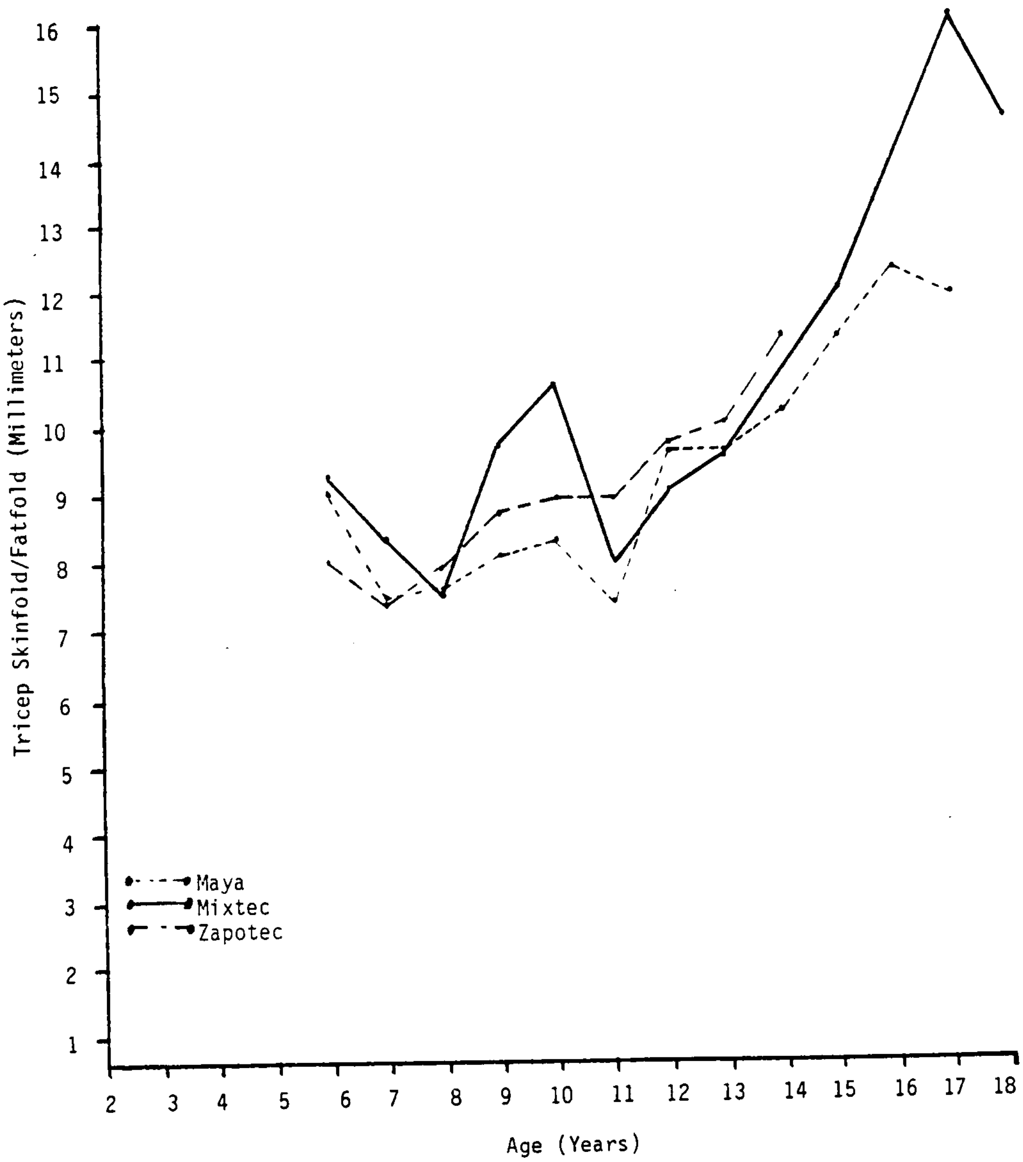


Figure 22. Mean female tricep skinfold/fatfold for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Sabharwal et al. 1966.
Zapotec--Malina et al. 1972.

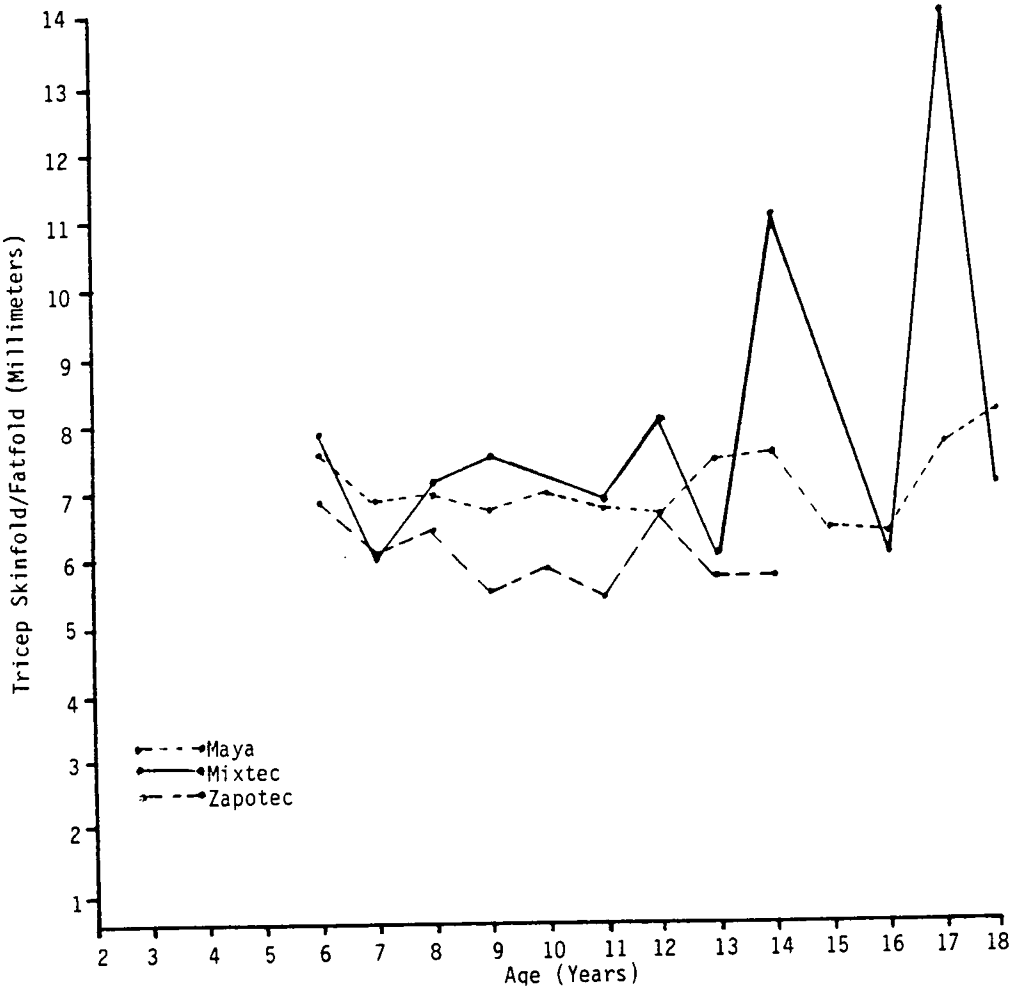


Figure 23. Mean male tricep skinfold/fatfold for age compared to others of Amerindian descent, 6 through 18 years.

Maya--Mendez and Behrhost 1963.
Zapotec--Malina et al. 1972.

The comparisons of this data with those of other Amerindian research samples have shown that with the exception of female height and weight, most of the other parameters fall within the range of the other cited studies. The variation in mean values may be due to the lack of an adequate sample size in each of the age groupings for comparison. Although all research samples compared are of Amerindian derivations, the differences demonstrate that there are factors other than genetic potential influencing the growth attainment process.

Head circumference. The majority of infant's and children's head circumference values fall within ± 2 standard deviations (SD) (Figure 24) of the international standard (Nellhaus 1968). All of the participants below age 2 are above -2 SD while the majority of the participants aged 2 through 18 years are below the mean but above -2 SD.

Weight Attainment

Children's weight parameters were evaluated for the percentage of deviation, by use of the Gomez scale, from the NCHS standard by use of nomograms developed by Dugdale (1984). Of the total child age participants (n=103), 28 (27.18%) were classified as normal, 38 (36.89%) were classified as Gomez Scale I, 30 (29.13%) were classified as Gomez Scale II, and 7 (6.78%) were classified as Gomez Scale III. Approximately 73% of the participants measured were classified into one of the three Gomez Scales. Using the Gomez scale classification and based upon participant's sex (Table 19),

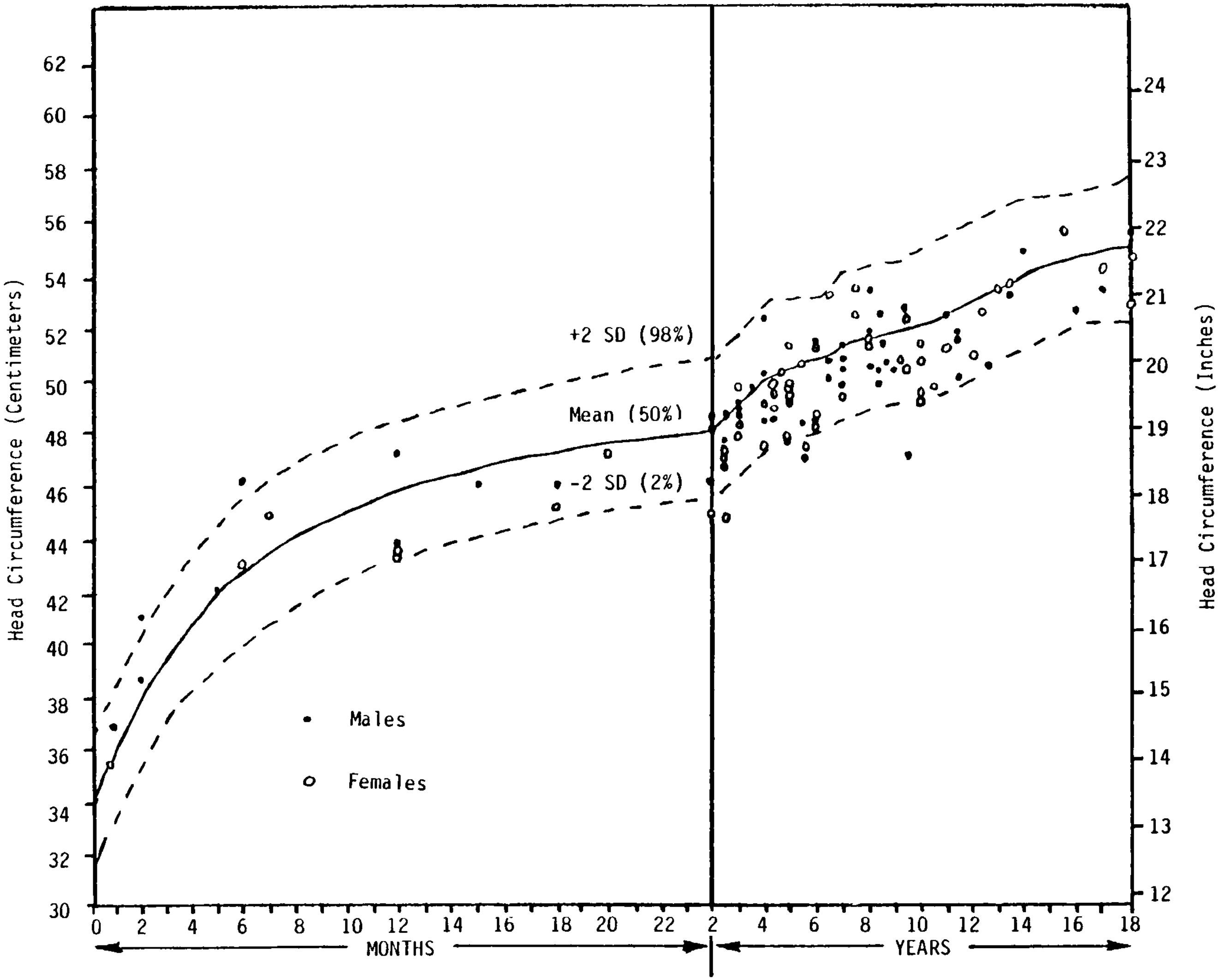


Figure 24. Head circumference, birth through 18 years of age.

Table 19. Gomez classification and participant's sex.*

	Gomez Classification					
	Grade I 90-75% of Expected Weight for Age		Grade II <75-60% of Expected Weight for Age		Grade III <60% of Expected Weight for Age	
Sex	Number	Percent	Number	Percent	Number	Percent
Female	14	36.84	16	53.33	6	85.71
Male	24	63.16	14	46.67	1	14.29
Total	38	100	30	100	7	100

*Chi square 6.226303, 2, 0.050.

female percentages in each Gomez grade increase while the percentages of males in each Gomez grade decrease. The association between the Gomez scale and sex was tested with Pearson's chi square statistic (6.226303, 2, 0.050) revealing a significant association.

Diarrheal incidence and the Gomez scale classification (Table 20) are not significantly associated when tested with Pearson's chi square statistic (4.6163078, 6, n.s.). The largest percentage of each Gomez classification is within the None (or no reported diarrheal episodes) category.

Table 20. Gomez classification and diarrheal incidence.*

Diarrheal Incidence	Gomez Classification: Grade I, 90-75% of Expected Weight for Age		Grade II, <75-60% of Expected Weight for Age		Grade III, <60% of Expected Weight for Age	
	Number	Percent	Number	Percent	Number	Percent
None	18	47.37	11	36.67	3	42.85
Mild	7	18.42	7	23.33	1	14.29
Moderate	3	7.89	2	6.67	2	28.57
Severe	10	26.32	10	33.33	1	14.29
Total	38	100	29	100	7	100

*Chi square 4.6163078, 6, n.s.

Height Attainment

The infant's and children's height was evaluated by the use of Waterlow's et al. (1977) definition of the stunting (<90% of reference standard). The percentage of deviation from the reference standard was again assessed by the nomograms developed by Dugdale (1984). The number of participants suffering from height stunting (<90% of reference standard) (Table 21) was not found to be associated with the participant's sex.

The percentages within each of the height attainment classifications were rather evenly divided between both sexes. In addition, diarrheal incidence and stunting of height in infants and children was not significantly associated (Chi square = 4.0162029, 4, n.s.).

Table 21. Height stunting (<90% of reference standard) and participant's sex.

	Height Attainment			
	<90% of Reference Standard		>90% of Reference Standard	
Sex	Number	Percent	Number	Percent
Female	19	45.24	30	49.18
Male	23	54.76	31	50.82
Total	42	100	61	100

Weight for Height Attainment

The weight for height parameter was assessed by utilizing the <80% of reference standard level as an indicator of wasting as defined by Waterlow and Rutishauer (1974) and Keller et al. (1976). Only four individuals (all females) were found to be below this weight for height level and no association was found between the weight for height parameter and diarrheal incidence (Chi square 1.6552665, 3, n.s.).

Upper-Arm Circumference

The upper-arm circumference which measures both subcutaneous fat and skeletal muscle and bone has been utilized as a more sensitive indicator of recent changes in nutritional status (McKay 1969; Hofvander and Eksmyr 1969). A limit set at 13.5 centimeters (cm), below which children are classified as malnourished, is a simple, sex-and-age independent measure, i.e., no children over 6 months should have an upper arm circumference below 13.5 cm. Anderson (1979) found in an international comparison that this age-constant arm circumference limit of 13.5 cm identified nearly all children with severe or acute malnutrition.

This upper-arm circumference limit of 13.5 cm (Table 22) identified seven participants (7.52%) who were classified as malnourished. This number parallels those in the Gomez classification III and identifies the female participant classified as wasted (<80% of reference standard). Again, diarrheal incidence was found not to be significantly associated with upper-arm circumference.

Table 22. Upper-arm circumference and diarrheal incidence.

Diarrheal Incidence	Upper Arm Circumference <13.5 Centimeters Frequency	Upper Arm Circumference >13.5 Centimeters Frequency
None	3	33
Mild	1	19
Moderate	2	10
Severe	1	24
Total	7	86

All of the parameters (weight, height, weight for height and upper-arm circumference) were found not to be associated with diarrheal incidence. Although stunting (<90% of standard) has occurred in 59.22% of the sample, the majority (96.12%) are at least at 80% of their weight for height. Seone and Latham (1971) pointed out that weight for height is an index of current nutritional status, while height for age gives an indication of past nutritional history.

Total Research Sample

The total research sample was assessed for possible association between all health status indicators and diarrheal incidence. A single factor regression analysis was utilized to detect factors which were significantly (0.05 alpha level) associated with diarrheal incidence. Of the nine health status indicators tested, only five were significant. The significant factors were: upper-arm circumference (F=12.33, 1, 0.0006), mid-arm muscle circumference (F=12.50, 1, 0.0005), head circumference (F=4.93, 1, 0.0277), height (F=13.30, 1, 0.004), and weight (F=13.64, 1, 0.0003). All of these factors had a negative slope, so that as diarrheal incidence decreased, the significant factor increased.

At least two interpretations can account for this phenomena. The first may be that all of these factors increased with age, so that the demonstrated trend is the result of age and not the specified factors. To test this interpretation, age was included in the total health status indicator model. If the observed association between upper-arm, mid-arm muscle, and head circumferences, height and weight were due to age, then age would be a significant factor in the prediction of diarrheal incidence. Age was not shown to be a significant factor in the total health status indicator model which attempts to predict diarrheal incidence.

The second possible explanation for this phenomena may be that each of the factors represents a component of the nutritional status of the participant. Height and weight are general indicators of nutritional status, upper-arm circumference is a measure of both calories and protein stores, mid-arm muscle circumference is a sensitive index of body protein stores and head circumference is an indicator of growth of head early in life. As the nutritional status of the individual (calories and/or protein stores) increases and/or improves, then diarrheal incidence decreases. An adequately nourished individual is better able to combat a diarrheal episode or other insult.

Total Health Status Indicator Model

All health status indicator variables including age were used to develop a model which best accounts for the variation in diarrheal incidence. The best model (F=7.54, 3, 0.0001) in which all variables had an alpha level of 0.05 or less was one which could account for only 11.69% of the variation in diarrheal incidence (Table 23). The model included height (F=12.21, 3, 0.0006), head circumference (F=3.98, 3, 0.0475), and the total number of tortillas prepared in the household (F=4.56, 3, 0.0341).

This model reflects three different areas of nutritional status. The height and head circumference parameter give an indication of past nutritional history, while the total number of tortillas reflects actual food intake and the number of individuals in the household. The model demonstrates that as height and number of tortillas increased, diarrheal incidence decreased.

Implications

The nutritional status of the participants does not indicate that the majority of the villagers are severely or even moderately malnourished. This is substantiated in infants and children by the weight for height assessment, in combination, with the upper-arm circumference parameter limit of below 13.5 cm, which identified

Table 23. Total health status indicator model.

Source	DF	Sum of Squares	Mean Squares	F	Prob>F
Regression	3	3,24302072	1.08100691	7.54	0.0001
Error	171	24.50223870	0.14328795		
Total	174	27.74525943			

only 7.52% of the sample as malnourished. The majority of these seven participants were identified as malnourished by all of the other growth assessment parameters.

The observation that none of the growth assessment parameters (Gomez scale, stunting, wasting, and upper arm circumference) were found to be associated with diarrheal incidence indicates that other factors are affecting the growth of the village children. These growth assessment parameters do not take into account the genetic potential, food availability, and socio-cultural beliefs and practices which may influence growth. The greatest rate of growth occurs before birth through age two when the infant is being breastfed and carried on someone's back.

The model which attempted to predict diarrheal incidence from health status indicators revealed that other factors are involved in diarrheal causation/incidence. In addition, diarrheal incidence was calculated with only reported diarrheal cases and does not take into account those diarrheal episodes which were not reported to the health clinic. Thus, the variable of diarrheal incidence may need refinement in the future to ascertain the number of diarrheal episodes which are not reported to the clinic. The information obtained in the health status analyses will be helpful in establishing the importance of health assessment in the clinic in an attempt to decrease diarrheal incidence. The incorporation of anthropometric measurements into the clinic protocol will enable the health personnel to identify those children which may be at risk of malnutrition.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This research study explored the role of environment, socio-cultural beliefs and practices, and health status indicators as factors causing diarrhea in the village of Santa Cruz Mixtepec. Due to the nature of this study, it was necessary to utilize a variety of research techniques (microbiological, anthropometric, interview, and observational) to document these possible interrelationships.

Discussion of Research Findings

Microscopic and microbiological analyses indicated that every tested vector (food, feces, water, and soil) contained agents that could cause diarrhea. The centralized water source was tested and found to be a microbiological satisfactory source. This relatively clean water became contaminated by placement into the collection vessels. Then, this contaminated (bacteria in numbers too numerous to count) water was utilized for all home-making activities.

An observation from the environmental area was that as the number of animals owned by the family increased, diarrheal incidence decreased. This finding may be accounted for by two possible mechanisms. The first may be that since the majority of individuals within this village are subsistence agriculturalists, the increase in animal number is equated with an increase in economic standing which may lead to a decrease in diarrheal incidence. Secondly, observations on animals within the village have demonstrated that they engage in "scavenger"-type activities. This "scavenger" activity means that all material which contains any possible nutrient is utilized as a food source by village animals.

The socio-cultural area of this study attempted to ascertain what, if any, socio-cultural beliefs and practices were related to diarrheal incidence. Although information obtained relating to hand washing practices and food preparation techniques did not yield a significant association with diarrheal incidence, the lack of association may be due to the participant's desire to give the expected answers. The socio-cultural beliefs pertaining to diarrheal causation and treatment when examined revealed that the cultural realm equated certain types of macroscopic stool characteristics (color of stool and the presence or absence of blood or mucus) with diarrheal treatment which parallels certain modern medicine methods. Diarrheal treatment consisted of the withdrawal or denial of "hot" or "cold" items depending on the perceived cause of the diarrhea.

A review of the health indicators of infants, children, and adults indicated that few individuals were severely or moderately malnourished. None of the health indicators were associated with diarrheal incidence which parallels studies done previously in the diarrhea field (Anonymous 1985). Height stunting occurred in approximately 50% of the children, while the weight for height parameters of these children are within the 95th and 5th centile limits. The villagers subsist on a marginal diet of the triad--corn, beans, and squash--but the only reliable quantitative information which could be gathered on food intake was the number of tortillas prepared in the household each day. Thus, an accurate assessment of the actual nutrient intake for each sampled individual was not possible.

Certain similarities were observed in the formulation of models for both the environmental and health status indicator areas. Environmental variables which were found to be associated with the incidence of diarrhea were the number of rooms in the home, total number of animals owned by the participant's family, and the presence or absence of Entamoeba histolytica in the fecal specimen. Factors from the health status indicator model found to be associated with diarrheal incidence were height, head circumference, and total number of tortillas prepared in the household. In each of these models, there is a factor associated with the density of individuals and/or animals (rooms in the home, total number of animals the participant's family owns, and total number of tortillas prepared in the household). The environmental model concentrates on the presence or absence of an established route of contamination. The health status model concentrates on height, head circumference (indicators of nutritional status), and total number of tortillas prepared in household (nutrient intake).

A model was developed to include both environmental and health status factors which best predict the total variance in diarrheal incidence. The diarrheal incidence model (F=13.12, 3, 0.0001) (Table 24) contained three variables which were found to account

Table 24. Total diarrheal incidence prediction model.

Source	DF	Sum of Squares	Mean Squares	F	Prob>F
Regression	3	5,30514198	1.76838066	13.12	0.0001
Error	159	21.42555986	0.13475195		
Total	162	26.73070184			

for 19.85% of the variation in diarrheal incidence and were significant at the 0.05 alpha level. The variables retained in this model were height (F=15.22, 3, 0.0001), total number of rooms in the home (F=22.37, 3, 0.0001), and total number of persons residing in the home (F=8.85, 3, 0.0034).

The retention of an indicator of density in all models indicated the importance of the number of rooms in the home, and the number of persons residing in the home. Additionally, the retention of the height variable indicated that knowledge of past nutritional history may be of importance in predicting diarrheal incidence. Inclusion of a factor pertaining to past nutrition may be due to the nature of independent variables since diarrheal incidence is calculated utilizing information from the past.

Conclusions

This study indicated that there is a limited ability to predict diarrheal incidence with these research variables. More research is needed to ascertain relationships among such dynamic variables as the environment, socio-cultural beliefs and practices, and health status. The most frequent approach to the documentation of an area with a decreased health status is for the government and/or agency to utilize capital (money) to eliminate the perceived problem. The input of money might be utilized in the village of Santa Cruz Mixtepec; several predicted outcomes could occur (Figure 25).

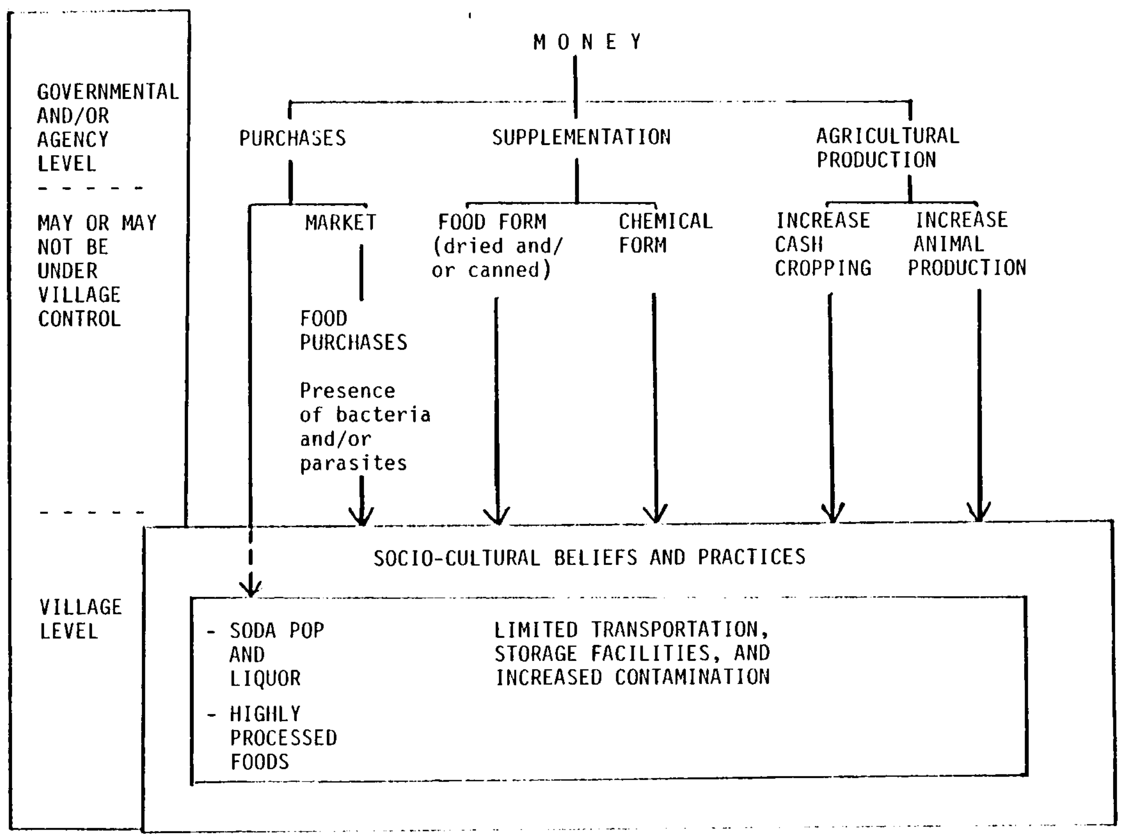


Figure 25. Possible outcomes of the sole use of capital to improve health status in the village of Santa Cruz Mixtepec.

The money has commonly been utilized in one of three ways:

1. To increase agricultural production which in the village context would include an increase in cash cropping (which may or may not be spent on improving health status), or increased animal production (which will further erode an unstable environment). The increased agricultural production was centered on consumable crops (corn, beans, and/or squash), and storage facilities within the village are limited.

2. To introduce supplements to the area, either in the food (canned and/or dried) or chemical form. Both supplementation forms must be congruent with the existing socio-cultural beliefs and practices of the villagers. The food or chemical form must be able to resist contamination and be easily stored.

3. To give money directly to the individual families of the villagers. This money could then be utilized in two ways: (1) to make food purchases at the market in San Juan Mixtepec, which this study has demonstrated is contaminated with bacteria and/or parasites and/or (2) to purchase directly soda pop, liquor, and/or highly processed food (high calorie-low nutrient density) in the village.

None of the three ways of utilizing money attempt to view poor health status or other related health factors within the dynamic system in which they occur. Further research must be conducted to ascertain the most effective solution to the problem.

The information gathered from this study will be utilized to develop an implementation plan for diarrheal control which uses the existing socio-cultural belief and practice system. Information documenting and assessing the socio-cultural beliefs and practices must be analyzed to develop a solution to the diarrheal problem. Following the analysis, the practices are assigned a priority for correction by selecting those which can be used to enhance an educational program and those which will need modification because they are contributing to the diarrheal problem.

In this instance, there are several areas in which the documented socio-cultural practices may be used to enhance the diarrheal control program.

The villager's macroscopic observations pertaining to diarrheal classification can be used to provide common ground on which to possibly introduce information about bacterial contamination. Even if the information pertaining to bacterial contamination is not introduced perhaps reinforcement that their macroscopic observations are valid even within the clinic setting may ease some villagers' anxiety about seeking treatment.

The ascertainment of whether the diarrhea is "hot" or "cold" is a practice that needs to be maintained. By assessing the precise humoral classification, one may begin to encourage the patient and/or family that he/she needs to consume a balanced diet. This can be achieved regardless of the humoral classification of the diarrhea (Appendix G).

The villagers should be encouraged to continue to utilize their domestic clay containers which through their shape reduce the surface area available for contamination. The amount of contamination could be further reduced by placing a cover on the top of the vessel.

A factor which is contributing to the contamination problem is that it is not feasible at this time to encourage the villagers to boil water because the supply of organic material for maintaining fires is very scarce. However, future planning should take into account that heat can be utilized to make food safer. Reforestation must be an important part of any development program in the village.

There remains much research to be done in order to understand the dynamic nature of culture, environment, and health status involved in diarrheal incidence and/or causation.

LIST OF REFERENCES

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Agarwal, K., B. Panhorta, B. Walia, A. ayyagari, and P. Joshi
1981 Acute diarrhea in infants and children: A bacteriological study. Indian Pediatrics 18: 369-372.

Anderson, M.
1979 Comparison of anthropometric measures of nutritional status in preschool children in five developing countries. American Journal of Clinical Nutriton 32: 2339-2345.

1981 Health and nutrition impact of potable water in rural Bolivia. Journal of Tropical Pediatrics 27: 39-48.

Anonymous
1985 Does malnutrition predispose children to diarrhea? Nutrition Reviews 43: 144-145.

Barrell, R., and M. Rowland
1979 Infant foods as a potential source of diarrheal illness in rural West Africa. Transactions of the Royal Society of Medicine and Hygiene 73: 85-90.

BBL
1968 Laboratory Manual. Manual of Products and Laboratory Procedures.

Black, R., M. Merson, A. Rahman, M. Yunus, A. Alim, I. Huq, R. Yolken, and G. Curlin
1980 A two year study of bacterial, viral, and parasitic agents associated with diarrhea in rural Bangladesh. Journal of Infectious Diseases 142: 660-664.

Black, R., K. Brown, and S. Becker
1982 Contamination of weaning foods and transmission of enterotoxigenic Escherichia coli diarrhoea in children in rural Bangladesh. Transactions of the Royal Society of Tropical Medical Hygiene 26: 259-264.

Bloom, A.
1984 International health: The impact of applied social sciences on health policies on international development organization. Southern Anthropological Society Annual Meeting, Ramada Inn, Capital Plaza, Atlanta, GA, April 19, 1984.

Bomba, W.
1982 Sanitation aspects of water supply and excreta disposal. In: Water Supply and Sanitation in Developing Countries.

E. Schiller and R. Droste, eds. Ann Arbor, Michigan: Ann Arbor Science Publishers, pp. 311-325.

Bradley, D.
1970 Health problems of water management. Journal of Tropical Medicine and Hygiene 73: 286-288.

Brown, A.
1984 Agricultural policy and child health in rural Mexico. Southern Anthropological Society Annual Meeting, Ramada Inn, Capital Plaza, Atlanta, GA, April 19, 1984.

Capparelli, E., and L. Mata
1975 Microflora of maize prepared as tortilla. Applied Microbiology 29: 802-806.

Chambers, R., R. Longhurst, D. Bradley, and R. Feachem
1979 Seasonal Dimensions to Rural Poverty: Analysis and Practical Implications. Brighton, England: Institute of Developmental Studies, University of Sutton.

Committee on Nutritional Anthropometry of the Food and Nutrition Board of the National Research Council
1956 Recommendations concerning body measurements for the characterization of nutritional status. Human Biology 28: 111-288.

Cramblett, H., P. Azimi, and R. Haynes
1971 The etiology of infectious diarrhea in infancy. Annals of the New York Academy of Science 176: 80-97.

Cruickshank, R., K. Standard, and L. Russell
1976 Epidemiology and community health in warm climate countries. Edinburgh: Churchill Livingstone.

Donoso, G.
1979 Weanling diarrhea: An overview of its nutrition and public health importance. The Journal of Nutrition and Dietetics 16: 103.

Dugdale, A.
1984 Nomograms for monitoring nutritional status. Ecology of Food and Nutrition 14: 59-62.

Echeverra, P., B. Harrison, C. Tirapat, and A. McFarland
1983 Flies as a source of enteric pathogens in a rural village in Thailand. Applied and Environmental Microbiology 46: 32-36.

Edberg, S., and S. Berger
1983 Antibiotics and Infection. New York: Churchill Livingstone.

Flewett, T., A. Bryden, and H. Davies
1975 Epidemic viral enteritis in a long stay children's ward. Lancet 1: 4.

Foster, G.
1974 Medical anthropology: Some contrasts with medical sociology. Medical Anthropology Newsletter 6: 1-6.

Gomez, F., R. Ramos-Galvan, J. Cravioto, and S. Frenk
1955 Malnutrition in infancy and childhood with special reference to kwashiokor. In: Advances in Pediatrics, Vol. VII, S. Z. Levine (ed.) Chicago: Yearbook Publishers.

Gracey, M., A. Suharjono, J. Sunoto, and D. Stone
1973 Microbial contamination of the gut: Another feature of malnutrition. American Journal of Clinical Nutrition 26: 1170.

Grady, G., and G. Keunsch
1971 Pathogensis of bacterial diarrhea. New England Journal of Medicine 285: 891.

Greenberg, H., and A. Kapikian
1978 Detection of Norwalk agent antibody and antigen by solid-phase radioimmunoassay and immune adherence haemmagglutination assay. Journal of American Medical Association 173: 620-623.

Gupte, S., and A. Sasan
1983 Maternal beliefs and attitudes concerning diarrheal disease. Journal of Diarrheal Disease Research 1: 109.

Hamill, P., T. Drizd, C. Johnson, R. Reed, and A. Roche
1977 NCHS growth curves for children birth-18 years, United States. Vital and Health Statistics, Series 11, No. 165. Hyattsville: USDHEW.

Harries, J.
1976 The problem of bacterial diarrhea. In: Acute Diarrhea in Children. London: Cibia Foundation Symposium, pp. 3-16.

Harris, J., H. DuPont, and R. Hornick
1972 Fecal leukocytes in diarrheal illness. Annuals of Internal Medicine 76: 697-703.

Hofvander, Y., and R. Eksmyr
1969 Changes in upper-arm circumference and body weight in a two-year follow-up of children on applied nutrition programme in an Ethiopian highland village. Journal of Tropical Pediatrics 15: 251-254.

Hollister, A., M. Beck, A. Gittelsohn, and E. Hemphill
1955 Influence of water availability on Shigella prevalence in children of farm labor families. American Journal of Public Health Association 45: 354-365.

Ibach, T.
1985 Personal communications.

International Commission on Microbiological Specifications in Foods
1974 Microorganisms in foods. 2. Sampling for microbiological analysis: Principles and specific applications. Toronto: University of Toronto Press.

Jaili, F., J. Fraley, E. Smith, V. Nichols, E. Klein A. Mintz, and B. Nichols
1982 Malnutrition in infants with acute diarrheal syndrome. Journal of Pediatric Gastroenterological Nutrition 1: 219-225.

Jelliffee, D.
1966 The Assessment of the Nutritional Status of the Community. Geneva: World Health Organization. Monograph Series No. 53.

Jenkins, C.
1980 Patterns of Protein-Energy Malnutrition Among Preschoolers in Belize. Ph.D. Dissertation, The University of Tennessee, Knoxville.

Kapikan, A., H. Kim, and R. Wyatt
1978 Human rotavirus-like agent as the major pathogen associated with "winter" gastroenteritis in hospitalized infants and young children. New England Journal of Medicine 294: 965-972.

Kazimi, L., and H. Kazimi
1979 Infant feeding practices of the Igbo, Nigeria. Ecology of Food and Nutrition 8: 111-114.

Keller, W., G. Donoso, and E. DeMayer
1976 Anthropometry in nutritional surveillance: A review based on results of the WHO Collaborative study of nutritional anthropometry. Nutritional Abstract Review 46: 591-592.

Kirk, D.
1983 Recent demographic trends and present population prospects for Mexico. <u>Food Research Institute Studies</u> 19: 93-111.

Konno, T., H. Suzuki, and A. Imai
1978 A long-term survey of rotavirus infections in Japanese children with acute gastroenteritis. <u>Journal of Infectious Diseases</u> 138: 569-576.

Korzeniowski, O., F. Barada, J. Rouse, and R. Guerrant
1979 Value of examination for fecal leukocytes in the early diagnosis of <u>Shigella</u>. <u>American Journal of Tropical Medicine and Hygiene</u> 28: 1031-1035.

Krugman, S., and Katz, S.
1981 <u>Infectious Disease of Children</u>. St. Louis: The C. V. Mosby Company.

Kumar, V., C. Clements, K. Marwah, and P. Diwedi
1981 Maternal beliefs regarding diet during acute diarrhea. <u>Indian Journal of Pediatrics</u> 48: 599-603.

Lam, S.
1982 Current concepts on etiology and pathogensis of diarrhea caused by viruses. <u>Southeast Asian Journal of Tropical Medicine and Public Health</u> 13: 325-330.

Lenette, E., E. spauling, and J. Truant (eds.)
1974 <u>Manual of Clinical Microbiology</u>. Washington, D.C.: American Society for Microbiology.

Lieberman, L., S. Simpson, and R. Thomas
1984 Growth patterns related to illness and seasonality among economically disadvantaged children in Costa Rica. 53rd Annual Meeting of the American Association of Physical Anthropologists, Philadelphia, PA, April 12, 1985.

Lishnevsky, P.
1977 Oral rehydration treatment benefits Laos children with diarrhea. <u>World Health Organization Chronicle</u> 311: 142.

Maina, A.
1979 Beliefs and practices concerning measles and acute diarrhea among the Akamba. <u>Tropical Geographic Medicine</u> 31: 139.

Malina, R., H. Selby, and L. Swartz
1972 Estatura, peso y circumferencia del brazo en una muestre transversal de ninos Zapotecas de 6 a 14 anos. <u>Anales de Antropologia</u> 9: 143-155.

Martorell, R., C. Yarbrough, S. Yarbrough, and R. Klein
1980 The impact of ordinary illnesses on the dietary intakes of malnourished children. American Journal of Clinical Nutrition 33: 345-355.

Mata, L., J. Urrutia, and B. Garcia
1967 Nutrition and infection. Effect of infection and diet on child growth: Experiences in a Guatemalan village. Wolhemholme, G., and O'Connor, M. (eds.) Cibia Foundation Study Group, pp. 112-126.

Mata, L., J. Urrutia, B. Garcia, R. Fernadez, and M. Behar
1969 Shigella infection in breast-fed Guatemalan Indian neonates. American Journal of Diseases in Children 117: 142.

Mata, L., A. Simhon, and R. Padilla
1982 Diarrhea associated with rotavirus, enterotoxigenic Escherichia coli, Camplyobacter and other agents in Costa Rican children, 1976-1981. American Journal of Tropical Medicine and Hygiene 32: 146-153.

Mata, L., A. Simhon, J. Urrutia, R. Kronmal, R. Fernadez, and B. Garcia
1983 Epidemiology of rotavirus in a cohort of 45 Guatemalan Mayan children observed from birth to the age of three years. Journal of Infectious Diseases 148: 45-464.

McKay, D.
1969 Experience with the mid-arm circumference as a nutritional indicator in field surveys in Malaysia. Journal of Tropical Pediatrics 15: 205-210.

Mendez, J., and C. Behrhost
1963 The anthropometric characteristics of Indian and urban Guatemalans 1961. Human Biology 35: 457-469.

Micro Filtration Systems
1983 Manual on membrane filter technique. Microbiology by Membrane Filter Technique, pp. 6-15.

Miller, M.
1984 Gastrointestinal infections: Diarrheal diseases. In: The Theory and Practice of Infection Control, I. Gurevich, P. Tafuro, and B. Cunha (eds.), New York: Praeger Publishers, pp. 306-323.

Muttamara, S., and M. Krishaswamy
1982 Diarrheal disease related to sanitation and water supply. Southeast Asian Journal of Tropical Medicine and Public Health 13: 348-351.

Nellhaus, G.
1968 Composite international and interracial graphs. Pediatrics 41: 106-120.

Nelson, J., and K. Haltalin
1971 Accuracy of diagnosis of bacterial diarrheal disease by clinical features. Journal of Pediatrics 78: 519-522.

Noche, M.
1982 Environmental factors in diarrheal diseases in the Philippines. Southeast Asian Journal of Tropical Medicine and Public Health 13: 352-356.

Ortiz, B., and H. Mora
1967 Somatometria en escolares de Tlaltizapan, Mr. (a) Analisis del peso y de la talla. (b) Diversos parametros excludos peso y talla. Boletin Medico del Hospital Infantil (Mexico) 24: 291-329.

Pan American Health Organization (PAHO)
1980 Enfermedades diarreicas en las Americas. Bolletin de Epidemilogia 1: 1-4.

Puffer, R., and C. Serrano
1973 Patterns of mortality in childhood. Pan American Health Organization Scientific Publication. Number 262.

Rahaman, M., K. Aziz, M. Munshi, Y. Patwari, and M. Rahman
1982 A diarrhea clinic in rural Bangladesh: Influence of distance, age, and sex on attendance and diarrheal mortality. American Journal of Public Health 72: 1124-1128.

Rohde, J.
1979 What we can do about weanling diarrhea, how to do it. The Indian Journal of Nutrition and Dietetics 16: 127-130.

Sabharwal, K., S. Morales, and J. Mendez
1966 Body measurements and creatinine excretion among upper and loewr socioeconomic groups of girls in Guatemala. Human Biology 38: 131-140.

Schliessman, D.
1959 Diarrheal disease and the environment. Bulletin of the World Health Organization 21: 381-392.

Schneider, R., M. Shiffman, and J. Faigenblum
1978 The potential effect of water on gastrointestinal infections prevalent in developing countries. The American Journal of Clinical Nutrition 31: 2089-2098.

Seone, N., and M. Latham
1971 Nutritional anthropometry in the identification of malnutrition in childhood. Journal of Tropical Pediatrics and African Child Health 17: 98-104.

Shiffman, M., and R. Schneider
1976 The development and evaluation of measures to reduce food wastes caused by intestinal disease. Annual Progress Report for AID, Contract Number csd. 2959.

Spores, R.
1967 The Mixtec Kings and Their People. Norman, OK: The University of Oklahoma Press.

Srinivasa, D.
1977 Impact of health services in a rural community of south India. I.C.M.R. enquiry. Mimeographed report.

Srinivasa, D., and E. Afonso
1983 Community perception and practices in childhood diarrhea. Indian Pediatrics 20: 859-864.

Stetler, H., F. Trowbridge, and A. Huong
1981 Anthropometric nutrition status and diarrhea prevalence in children in El Salvador. Journal of Tropical Medicine and Hygiene 30: 888-895.

Stoll, B., R. Glass, H. Banu, M. Huq, M. Khan, and M. Ahmed
1983 Value of stool examination in patients with diarrhoea. British Medical Journal 286: 2037-2040.

Tanner, J., and R. Whitehouse
1962 Standard of subcutaneous fat in British children. British Medical Journal 1: 446-452.

Tharavanij, S.
1982 Pathogensis of diarrhoea caused by parasites. Southeast Asian Journal of Tropical Medicine and Public Health 13: 331-338.

Trivedi, B., H. Gandhi, and N. Shukla
1971 Bacteriologic water quality and incidence of water borne diseases in a rural population. Indian Journal of Medical Science 25: 795.

United States Public Health Services, Health Resources Administration
1976 NCHS Growth Charts. Rockville, Maryland: Public Health Service (HRA 76-1120, 25, 3).

Unrau, G.
1975 Individual household water supplies as a control measure against Schistosoma mansonii: A study in rural St. Lucia. Bulletin of the World Health Organization 52 (1).

Vermeer, D., and R. Ferrell
1985 Nigerian geographical clay: A traditional antidiarrheal pharmaceutical. Science 227: 634-636.

Walzer, P., M. Wolfe, and M. Schultz
1971 Giardiasis in Russia. Journal of Infectious Diseases 124: 235-239.

Waterlow, J., and I. Rutishauer
1974 Malnutrition in man. In: Early Malnutrition and Mental Development. symposia of the Swedish Nutrition Foundation, XII, Uppsala: Almqvist and Wiksells, pp. 13-26.

Waterlow, J., R. Bozina, W. Keller, J. Lane, M. Nichaman, and J. Tanner
1977 The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of ten years. Bulletin of the World Health Organization 55: 489-498.

Watkinson, W.
1981 Delayed onset of weanling diarrhea associated with high breast milk intake. Transactions of the Royal Society of Tropical Medicine and Hygiene 75: 432-437.

White, G., T. Bradley, and A. White
1972 Drawers of Water, Domestic Water Use in East Africa. Chicago: The University of Chicago Press, 306pp.

Winbold, U., W. Kilawa, and K. Torstensson
1980 Sanitation without Water. Stockholm, Sweden: Swedish International Development authrotiy.

Wolff, H.
1969 The faecal smear in the therapy of diarrhoeas. Tropical Geographic Medicine 21: 427-435.

World Health Organization
1971 International Standards for Drinking Water. 3rd edition. Geneva: World Health Publications.

1976a Methodology of nutritional surveillance. Technical Report Series 593. Geneva: World Health Publications.

1976b Microbiological aspects of food hygiene. Technical Report Seris 598. Geneva: World Health Publications.

1979 Parasitic zoonoses. Technical Report Series 637. Geneva: World Health Publications.

1980 Environmental Health and Diarrheal Disease Prevention. Geneva: World Health Publication.

1983 World Health Statistics. Geneva: World Health Publication.

1984a Weekly Epidemiological Record 58: 241-243.

1984b The role of food safety in health and development. Technical Report Series 705. Geneva: World Health Publication.

Wyatt, R., and L. Mata
1969 Bacteria in colostrum and milk of Guatemalan Indian women. Journal of Tropical Pediatrics 15: 159-171.

Yolken, R., R. Wyatt, G. Zissis, C. Brandt, W. Rodriguez, H. Kim, R. Parrott, J. Urrutia, L. Mata, H. Greenberg, A. Kapikian, and R. Chanock
1978 Epidemiology of human rotavirus type 1 and 2 as studied by enzyme linked immunosorbent assay. New England Journal of Medicine 299: 1156-1167.

Zerfas, A.
1975 The insertation tape: A new circumference tape for use in nutritional assessment. American Journal of Nutrition 28: 782-786.

APPENDICES

APPENDIX A

PERMISSION TO CONDUCT STUDY IN VILLAGE OF SANTA CRUZ MIXTEPEC

To Whom It May Concern:

We are pleased to have Paula M. Butler work with the health clinic in Santa Cruz Mixtepec, Juxtlahuaca, Oaxaca, Mexico, during June 21, 1984-August 18, 1984, investigating factors which may contribute to the incidence of diarrhea. The data and results obtained from this investigation will be utilized to develop a diarrheal control program and other educational programs for this village. While collecting the data, Mrs. Butler will assist the medical clinic personnel with laboratory analyses and training of the medical clinic personnel. Her service this summer will enable our clinic personnel to be more specific in their treatment of diarrhea.

V/o B/o

EL AGENTE MUNICIPAL.

[illegible] LOPEZ SANTIAGO

ALCALDE 1o. CONSTITUCIONAL.

MAXIMINO [illegible]

SECRETARIO MUNICIPAL.

BENITO MARTINEZ HERNANDEZ.

AGENCIA MUNICIPAL
Santa Cruz Mix[illegible]
Juxtlahuaca, Oax.

APPENDIX B

APPROVAL FOR RESEARCH INVOLVING

HUMAN SUBJECTS

THE UNIVERSITY OF TENNESSEE, KNOXVILLE
KNOXVILLE 37996-0140

OFFICE OF THE VICE CHANCELLOR
FOR RESEARCH

404 ANDY HOLT TOWER

AREA 615
TELEPHONE: 974-3466

June 15, 1984

Paula M. Butler
Dept. of Anthropology
South Stadium Hall
CAMPUS

Dear Ms. Butler:

The Committee on Research Participation has reviewed your project, "Environmental, Sociocultural, and Health Factors Related to Diarrhea in Santa Cruz Mixtepec, Juxtalahuaca, Daxaca, Mexico," CRP #1560. Having received the changes upon which approval was contingent, the project is now approved.

Responsibilities of the investigator during the conduct of this project include the following:

1. Obtain prior approval from the Committee before instituting any changes in the project.
2. Retain signed consent forms from subjects for at least three years following completion of the project.
3. Submit a Form D to report termination, to renew approval, or to report changes in the project at 12-month or less intervals.

The Committee wishes you every success in your research endeavor.

Sincerely,

Jo Lynn Cunningham, Acting Chair
Committee on Research Participation

scw

cc: Dr. L. Evans Roth
Dr. William M. Bass
Dr. Mary A. Bass

APPENDIX C

INTERVIEW SCHEDULE

INTERVIEW SCHEDULE

Code Number: 1 - ______

I. Name:
<u>Nixi</u> <u>nani</u> <u>ni</u>:

Age:
<u>Nisa</u> <u>cuia</u> <u>yee</u> <u>ni</u>?

II. Parents' Names

1. Father:
<u>Nixi</u> <u>nani</u> <u>tata</u> <u>ni</u>?

2. Mother:
<u>Nixi</u> <u>nani</u> <u>nana</u> <u>ni</u>?

III. Home

1. How many children are there in your family?
<u>Nisa</u> <u>tahan</u> <u>ni</u> <u>cuu</u>?

   A. Males and ages:
   <u>Nisa</u> <u>cuia</u> <u>yee</u> <u>cuee</u> <u>chaa</u>?

   B. Females and ages:
   <u>Nisa</u> <u>cuia</u> <u>yee</u> <u>cuee</u> <u>naha</u>?

2. How many people live in your home?
<u>Nisa</u> <u>tahan</u> <u>ni</u> <u>yee</u> <u>ini</u> <u>vehe</u> <u>ni</u>?

3. How many rooms are there in your home?
<u>Nisa</u> <u>cuarto</u> <u>luu</u> <u>yee</u> <u>ini</u> <u>vehe</u> <u>ni</u>?

IV. Environmental

1. Does your family keep animals?
<u>A</u> <u>yee</u> <u>sana</u> <u>cuee</u> <u>ni</u>?

2. What kind (type) of animals?
<u>Nchi</u> <u>sana</u> <u>cuii</u>?

3. How many?
<u>Nchi</u> <u>sana</u> <u>cuii</u>

4. Where are they kept?
<u>Nchi</u> <u>ingna</u> <u>ti</u>?

5. Where do they graze?
   Nchivi catsahan ti?

6. Where do you get your water from?
   Nchici nadaguihin ni chauii coho cueeni?

7. Do you always get your water from there?
   A meso ica ndaguihin ni ra?

8. How many trips (burro) does it take per month to get your wood?
   Nchivi ndaguihin ni tutu?

9. How long for you leave it burning?
   A cahun ni nuhu ndisaa hora iin guii?

V. Socio-cultural

1. When do you wash your hands?
   Nchivi nadaha ni?

2. Who is the person responsible for preparation of your food?
   Ana nadasavaha nchaii catsi cuee ni?

3. What causes diarrhea?
   Chanu tsa yee cuehe cuun titsi ni?

4. How do you treat diarrhea?
   Nixi saha ni tatu nicuun titsi ni?

5. Are there any special foods you eat when you have diarrhea?
   A yee na vaha catsi ni, a coho ni ta nicuun titsi ni?

6. Are there any special foods you do not eat when you have diarrhea?
   A yee na cuanuhu tatu nicuun titsi ni?

7. Do you wash your hands:
   A ndaha ni:

   A. after defecating?
      tantsinu tsa nchacha guini ni?

   B. before eating?
      ta ncha gaa catsahan ni?

   C. before preparing foods?
      ta ncha gaa ndasavahan ni?

D. while getting water?
ta ncha gaa cohoni chacuii?

VI. Health Status

1. Have you been to the health clinic this year?
A tsa tsahan ni clinica cuia vichi?

2. If so, how many times?
Tatu tsatsahan ni clinica, ra nisa chencha cuii?

3. For what?
Nchi ndoho ni?

4. What does/do she/they usually fix to eat? How many tortillas?
Nchi catsi cuee ni?

5. What did you eat today? How much?
Nchi tsa ntsatsi ni vichi, nisa staa tsatsu?

6. Anthropometric measurements:

A. Weight

B. Height

C. Head circumference

D. Mid-arm circumference

E. Tricep skinfold

APPENDIX D

WATER SOURCES

LABORATORY PROCEDURE FOR WATER SOURCES

The test used to determine the amount of contamination in the water, called the membrane filter technique, involved filtering the water to be tested through a membrane filter sitting on a screen into a flask by creating a vacuum with an air pump (Micro Filtration Systems 1983). The laboratory equipment was a field test kit provided by the Water Microbiology section of the State of Tennessee Health Department. Water to be tested was collected in a sterile water bottle and brought back to the clinic where it was tested within 24 hours of the collection time.

Faucet Source

If the water collected was from a faucet, 100 milliliters of it was tested using M-endo broth as the media. On M-endo media, colonies of coliform bacteria develop a green sheen (BBL 1968). Before the water could be filtered, 2 milliliters of M-endo broth was added to a tight-fitting petri dish with an absorbent pad in it. Once the petri dish was ready, the water could be filtered. One hundred milliliters of the water was poured into a funnel; then, by creating a vacuum the water was pulled through a screen that had a membrane filter sitting on top of it. After passing through the filter, the water was collected in a flask under the filter. The funnel was then removed and the membrane filter was taken from the screen using sterilized tweezers. This membrane was placed in the petri dish containing the M-endo media. The petri dish was then placed upside down in an incubator set at 35°C for 24 hours. The counted metallic colonies on the incubated plate indicated the presence of coliform bacteria; the colonies were presumably *Escherichia coli*, but no conclusive tests were done to confirm this.

River Source

The testing process for river water was essentially the same as the process for the faucet source. Since it was known that the river water was contaminated, it was tested for fecal coliforms only. The broth used for fecal coliforms was M-FC broth; fecal coliforms from blue colonies on M-FC media (BBL 1968). This broth was also added to an absorbent pad in a tight-fitting petri dish in 2 milliliter increments. The filtering process used for the river water was identical to the process for the faucet source; the only difference was in the amount of water being filtered. Since the river was so polluted, smaller amounts had to be used so that the resulting colonies would be in the countable range, which for fecal coliforms was between 10-70 colonies. Usually three different amounts per sample of river water were tested: 5.0 milliliters, 2.5 milliliters, and 1.0 milliliters. If the rains were especially heavy, a 0.1 milliliter and 0.01 milliliter sample were tested. The petri dish containing the M-FC media were incubated upside down in a water bath at 44.5°C for 24 hours. The counted coliform colonies on the M-FC plates were presumed to be *Escherichia coli*, but again this was not confirmed.

APPENDIX E

FECAL AND SOIL SOURCES

LABORATORY PROCEDURE FOR FECAL SPECIMENS

All fecal specimens regardless of source were examined macro- and microscopically. The delay for analysis of fecal specimen was kept to approximately no more than 4 to 6 hours between time of collection and examination.

Macroscopic examination. During this gross examination, the specimen was inspected for: (1) evidence of intestinal pathology (blood and mucus), (2) substance that may interfere with the microscopic examination, and (3) consistency of the specimen. All of these factors were noted for each participant's sample.

Microscopic examination. Two types of microscopic examination, iodine and saline preparation, were done on each specimen.

Iodine preparation was used to stain protozoan cysts in a wet mount. A small portion of feces was comminuted in a drop of iodine solution to one side of the slide surface and mounted with a cover slip. In a correctly stained cyst, the glycogen appears reddish-brown, the cytoplasm appears yellow and the nuclei stand out as light refractile bodies. The location of karyosomes may be more easily determined, but the chromatid bodies are less visible than in saline solution. Since glycogen is a reserve food, it will not usually appear in older cysts.

Saline preparation. A small portion of feces was mixed in a drop of physiological saline on the other side of the slide surface and was covered with a cover slip. In a saline preparation, the trophozites and cysts may exhibit characteristic movement. Because of these properties, organisms may be more easily spotted in saline than any other type of preparation. Even though no stain is present, some structures, such as chromatid bodies of the amebic cysts, are more easily seen in saline.

LABORATORY PROCEDURE FOR SOIL SOURCES

The soil samples were examined microscopically in the same manner as the fecal specimens. Samples of the soil were collected on both rainy and dry days.

APPENDIX F

FOOD SOURCES

LABORATORY PROCEDURE FOR FOOD SOURCES

All food sources (fruit and vegetables) were purchased at the Friday open air market in San Juan Mixtepec. The analysis concentrated upon the outer surface (skin) through microbiological and microscopic examination.

All food sources (fruits and vegetables) were rinsed five times utilizing a sterile syringe with a single 5 milliliters of sterile physiological saline. The saline rinse was collected in a sterile petri dish and 2 milliliters each were used to inoculate trypticase soy agar (TSA) and eosin methylene blue agar (EMB). These plates were then incubated at 37°C and were examined at 24 and 48 hours to determine both the number and type of bacteria present.

The remaining approximately 1 milliliter of saline rinse was incubated at 37°C in a sterile petri plate and was microscopically examined 24 to 48 hours later. This examination was to aid in identification of possible microbes and parasites present.

APPENDIX G

HUMORAL CLASSIFICATION OF FOOD IN THE VILLAGE OF SANTA CRUZ MIXTEPEC

Table 25. Humoral classification of foods.

Food Type	Humoral Classification		
	Hot	Cold	Neutral/Refreshing
1. Breads and Cereals	tortillas	bread flour oatmeal	gruel (atole)
2. Dairy		milk	
3. Meats	chicken chicken eggs fish (dried) lamb	beef turkey turkey eggs goat pork rabbit	fish (canned) or in tomato sauce opossum
4. Vegetables	beans (black) beans (red) squash (calabasa) chiles	beans (haba) beans (gravel) squash (chilacayote) epazote garlic tomatoes	salsa
5. Fruits	bananas custard apples grapes nopal fruit oranges peaches (yellow)	apples lemons peaches (white) pineapples	
6. Fats, Oils, Sweets, and Beverages	corn cane sugar cane cane whiskey coca cola orange soda pepsi cola sugar (crude)	pork (lard) soda: apple, grapefruit, lemon, and strawberry honey sugar (refined)	coffee mineral water

*Source: Ibach 1985.

APPENDIX H

MEAN VALUES FOR ANTHROPOMETRIC MEASURES OF HEALTH STATUS INDICATORS

Table 26. Mean weights--pounds.

Age (Years)	Males			Females		
	Number	Mean	SD	Number	Mean	SD
0.083	1	9.50	----	1	7.00	----
0.167	2	11.50	0.00	-	----	----
0.417	1	14.50	----	-	----	----
0.500	1	19.00	----	1	12.00	----
0.583	-	----	----	1	18.00	----
1	5	16.92	4.62	4	15.50	6.01
2	5	21.90	5.24	5	19.82	5.47
3	5	26.50	2.74	2	20.50	6.36
4	4	31.80	0.91	6	31.92	4.29
5	5	33.00	2.26	7	34.57	5.44
6	4	42.37	6.78	4	36.86	3.79
7	3	40.33	5.48	3	39.67	10.21
8	7	49.93	3.15	2	40.75	0.35
9	4	51.25	7.64	3	50.73	6.21
10	-	----	----	5	51.60	5.63
11	4	52.75	9.21	1	66.00	----
12	1	68.00	----	2	56.25	3.18
13	1	74.00	----	2	82.00	2.83
14	1	100.50	----	-	----	----
15	-	----	----	1	77.50	----
16	1	94.50	----	-	----	----
17	1	112.50	----	1	115.00	----
18	1	102.00	----	2	105.00	7.07
Adults	22	121.34	17.21	45	104.09	14.67

Table 27. Mean weights--kilograms.

Age (Years)	Males			Females		
	Number	Mean	SD	Number	Mean	SD
0.083	1	4.32	----	1	3.18	----
0.167	2	5.23	0.00	-	----	----
0.417	1	6.59	----	-	----	----
0.500	1	8.64	----	1	5.45	----
0.583	-	----	----	1	8.18	----
1	5	7.69	2.09	4	7.05	2.73
2	5	9.95	2.38	5	9.01	2.49
3	5	12.05	1.24	2	9.32	2.89
4	4	14.45	0.41	6	14.50	1.95
5	5	15.00	1.03	7	15.71	2.47
6	4	19.26	3.08	4	16.76	1.72
7	3	18.33	4.51	3	18.03	4.64
8	7	22.69	1.43	2	18.52	0.16
9	4	23.30	3.47	3	23.11	2.82
10	-	----	----	5	23.45	2.56
11	4	23.98	4.18	1	30.00	----
12	1	30.91	----	2	25.57	1.45
13	1	33.64	----	2	37.27	1.29
14	1	45.68	----	-	----	----
15	-	----	----	1	45.68	----
16	1	42.96	----	-	----	----
17	1	52.27	----	1	51.14	----
18	1					
Adults	22	55.15	7.82	45	47.31	6.67

Table 28. Mean heights--centimeters.

Age (Years)	Males			Females		
	Number	Mean	SD	Number	Mean	SD
0.083	1	54.50	----	1	52.00	----
0.167	2	56.35	2.62	-	----	----
0.417	1	62.50	----	-	----	----
0.500	1	73.20	----	1	51.20	----
0.583	-	----	----	1	70.00	----
1	5	73.22	5.84	4	70.38	4.50
2	5	78.42	6.83	5	79.30	6.52
3	5	85.38	4.30	2	87.15	0.35
4	4	89.18	3.37	6	94.37	4.06
5	5	100.56	5.46	7	95.83	7.37
6	4	99.20	9.35	4	103.48	6.23
7	3	106.90	9.55	3	106.87	12.09
8	7	117.19	3.36	2	108.10	2.69
9	4	116.58	7.67	3	115.73	3.42
10	-	----	----	5	119.78	7.04
11	4	122.70	11.96	1	131.20	----
12	1	135.70	----	2	126.00	4.10
13	1	139.70	----	2	136.00	1.70
14	1	150.00	----	-	----	----
15	-	----	----	1	127.10	----
16	1	149.50	----	-	----	----
17	1	146.50	----	1	145.00	----
18	1	150.80	----	2	142.65	----
Adults	22	156.65	4.87	45	145.51	4.79

Table 29. Mean upper-arm circumferences--centimeters.

Age (Years)	Males			Females		
	Number	Mean	SD	Number	Mean	SD
0.083	1	11.50	----	1	11.20	----
0.167	2	13.45	0.35	-	----	----
0.417	1	0.00	----	-	----	----
0.500	1	14.60	----	1	0.00	----
0.583	-	----	----	1	13.50	----
1	5	14.46	0.90	4	14.18	6.78
2	5	13.50	6.93	5	14.32	1.01
3	5	13.94	7.29	2	15.20	1.84
4	4	15.38	0.97	6	15.27	0.70
5	5	14.84	0.84	7	13.79	6.12
6	4	16.83	1.04	4	15.95	7.97
7	3	16.50	0.50	3	15.80	0.78
8	7	16.76	0.75	2	16.75	0.35
9	4	15.30	3.47	3	17.70	1.41
10	-	----	----	5	17.58	1.20
11	4	16.40	1.16	1	19.80	----
12	1	18.00	----	2	17.40	0.42
13	1	19.00	----	2	21.05	0.49
14	1	22.00	----	-	----	----
15	-	----	----	1	22.50	----
16	1	22.10	----	-	----	----
17	1	24.20	----	1	26.00	----
18	1	24.60	----	2	25.30	----
Adults	22	23.06	7.77	45	22.12	7.81

Table 30. Mean triceps skinfolds/fatfolds--millimeters.

Age (Years)	Males Number	Males Mean	Males SD	Females Number	Females Mean	Females SD
0.083	1	6.00	----	1	0.00	----
0.167	2	9.50	0.71	-	----	----
0.417	1	0.00	----	-	----	----
0.500	1	11.00	----	1	0.00	----
0.583	-	----	----	1	8.00	----
1	5	6.40	4.16	4	5.50	3.87
2	5	9.40	2.51	5	9.20	1.92
3	5	9.60	5.81	2	9.50	2.12
4	4	9.25	2.36	6	8.17	2.04
5	5	6.80	1.10	7	8.14	3.80
6	4	7.75	1.26	4	9.25	0.96
7	3	6.00	0.00	3	8.33	1.53
8	7	7.14	2.85	2	7.50	3.54
9	4	7.50	3.00	3	9.67	1.53
10	-	----	----	5	10.60	3.13
11	4	6.75	1.71	1	8.00	----
12	1	8.00	----	2	9.00	1.41
13	1	6.00	----	2	9.50	0.71
14	1	11.00	----	-	----	----
15	-	----	----	1	12.00	----
16	1	6.00	----	-	----	----
17	1	14.00	----	1	16.00	----
18	1	7.00	----	2	14.50	0.71
Adults	22	7.00	3.30	45	11.89	5.32

Table 31. Mean mid-arm muscle circumferences--centimeters.

Age (Years)	Males			Females		
	Number	Mean	SD	Number	Mean	SD
0.083	1	9.62	----	1	11.20	----
0.167	2	10.47	0.58	-	----	----
0.417	1	0.00	----	-	----	----
0.500	1	11.15	----	1	0.00	----
0.583	-	----	----	1	10.89	----
1	5	12.45	0.92	4	7.45	5.62
2	5	9.05	6.26	5	11.43	1.11
3	5	9.93	5.69	2	12.22	1.17
4	4	12.47	0.37	6	12.70	0.68
5	5	12.70	0.83	7	11.23	5.00
6	4	14.39	0.97	4	9.05	7.71
7	3	14.62	0.50	3	13.18	0.55
8	7	14.51	1.10	2	14.40	0.76
9	4	12.95	4.40	3	14.66	
10	-	----	----	5	14.25	0.59
11	4	14.28	1.22	1	17.29	----
12	1	15.49	----	2	14.57	0.02
13	1	17.12	----	2	18.07	0.27
14	1	18.55	----	-	----	----
15	-	----	----	1	18.73	----
16	1	20.22	----	-	----	----
17	1	19.80	----	1	20.98	----
18	1	22.40	----	2	20.75	0.77
Adults	22	20.87	7.21	45	18.39	7.83

Table 32. Mean head circumferences--centimeters.

Age (Years)	Males			Females		
	Number	Mean	SD	Number	Mean	SD
0.083	1	36.60	----	1	35.40	----
0.167	2	39.56	2.05	-	----	----
0.417	1	42.00	----	-	----	----
0.500	1	46.20	----	1	43.00	----
0.583	-	----	----	1	44.80	----
1	5	46.06	1.42	4	44.58	1.84
2	5	47.78	1.13	5	46.08	1.13
3	5	48.74	0.78	2	49.00	0.99
4	4	49.90	1.89	6	49.03	0.98
5	5	48.56	1.25	7	49.31	1.40
6	4	50.58	1.20	4	50.30	2.34
7	3	50.23	0.57	3	51.40	2.04
8	7	50.93	0.91	2	51.45	0.21
9	4	50.93	2.82	3	51.00	1.06
10	-	----	----	5	50.06	1.20
11	4	51.25	0.90	1	51.20	0.57
12	1	49.20	----	2	52.00	0.57
13	1	52.40	----	2	53.40	0.28
14	1	55.20	----	-	----	----
15	-	----	----	1	55.40	----
16	1	52.50	----	-	----	----
17	1	53.70	----	1	53.30	----
18	1	55.60	----	2	53.85	----
Adults	22	55.00	1.06	45	53.76	1.41

VITA

Paula Merrell Butler was born to Mr. and Mrs. George Merrell, Jr., Beaufort, North Carolina, in 1954. Her father was in the Army throughout her elementary and junior high school years. After his retirement in 1968, she entered as a freshman at East Careteret High School, Beaufort, North Carolina, and graduated June 1972. She began her collegiate education at East Carolina University, Greenville, North Carolina in Medical Technology, graduated, and was registered in 1976. After graduating, she was employed as a Medical Technologist in Laboratory Medicine at Pitt County Memorial Hospital, Greenville, North Carolina.

Following her 1978 marriage to Howard L. Butler, she entered an undergraduate program at the University of North Carolina at Chapel Hill in Public Health Nutrition. She graduated with a B.S.P.H. in Public Health Nutrition in 1980 and began a M.S. program in Food, Nutrition, and Institution Management at East Carolina University, School of Home Economics and received her M.S. degree in 1982. In 1982, she began her doctoral studies at The University of Tennessee, Knoxville, with an emphasis in bio-cultural - nutritional anthropology. Her current plans are to continue her work in the area of community and applied nutrition.

Paula Merrell Butler is a registered Medical Technologist and registered Dietitian. Additionally, she is a full member of the American Dietetic Association and an associate member of Sigma Xi.