

748

# A Pilot Search for Environmental Factors Influencing Diarrheal Disease in Young Children in Panama

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Diarrheal disorders have long been reported in the developing countries as the leading cause of death in children during the first few years of life<sup>(1)</sup>. Panama is no exception as its statistical data on the problem reveal these disorders to be the major cause of death in infants and children and the sixth highest cause of death for the total population<sup>(2)</sup>.

The criteria used in Panama for the general diagnosis of this disorder, often referred to as simply diarrhea, is the passage of five or more stools within twenty-four hours or presence of mucus or blood in loose stools<sup>(3)</sup>.

Global research has resulted in the compilation of much information on this complex problem as influenced by the nation's internal and external environment. The complexity of the etiological and epidemiological factors, however, has hindered progress toward its control.

The first bacteriological evaluation of human diarrhea in Panama, undertaken in 1964, was a study of young children visiting the hospital outpatient clinic<sup>(4)</sup>. Results of the investigation showed only 7.9 per cent of the children with diarrhea and 1.4 per cent of the controls to have either *Escherichia coli*, *Salmonella*, or *Shigella*, the three main pathogenic organisms thought to cause diarrhea. Studies were then broadened to include environmental conditions thought to influence the presence of bacteria in diarrheal disease. Quality of housing was evaluated as a single factor<sup>(5)</sup>; findings were inconclusive except that the rates of diarrhea in the best type of housing differed from the other five substandard types. Later water and hygiene facilities were evaluated<sup>(6,7)</sup>; no direct relationship to diarrhea was found.

Upon review of other bacterial studies of diarrhea, one study of normal children found that

approximately one tenth had either enterovirus or some type of pathogenic bacteria in the stool with the prevalence varying with age, sex, area, season, and locality<sup>(8)</sup>. Pierce's examination of the feces of patients with diarrhea, revealed no regular occurrence of common pathogenic bacteria<sup>(9)</sup>. Other studies found little differences in the intestinal bacterial flora of well children and children with diarrhea<sup>(10, 11)</sup>. One, however, found quantitative rather than qualitative differences in the intestinal bacteria of the controls and the group with diarrhea<sup>(12)</sup>. More specifically, one group related that when infants were given food contaminated with bacteria normally found in the intestine, massive contamination and overgrowth of these organisms resulted<sup>(13)</sup>. This change could be a major factor in acute diarrheal disease because of the capacity of the large numbers of bacteria to upset the balance of the intestinal tract flora.

Diarrhea has been studied in relation to other causative agents besides bacteria. It was found to be associated with viruses and respiratory infection<sup>(14, 15, 16)</sup> but not significantly associated with the presence of intestinal helminths and protozoa<sup>(17)</sup>. Diarrhea has also been associated with antibiotic therapy. Some antibiotics have been shown to upset the balance of the intestinal flora by suppressing some organisms and permitting overgrowth of others, thereby either causing or increasing the severity and duration of diarrhea<sup>(18, 19)</sup>.

Studies have implicated some foods and animals as possible carriers of bacteria capable of causing diarrhea. Dried milk in the factory was found to contain both *Staphylococcus*<sup>(20)</sup> and *Salmonella*<sup>(21)</sup>. Lizards were shown to harbor *Salmonella* organisms<sup>(22)</sup>.

The INCAP groups working in Guatemala since the 1950's have done the most complete and continuous investigation of the epidemiology and etiology of diarrhea with respect to environment and nutrition. One group concluded that the social environment appeared to exert its greatest effect, not through the type of housing, but through the population density in living compounds and habits of the people in relation to care of water, wastes, and food consumed<sup>(23)</sup>. As to specific

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waste disposal, they concluded that privies contributed little to the control of diarrheal disease<sup>(2, 29)</sup>. In the study of water facilities, diarrheal infection rates were found to be higher where water was least available for personal hygiene<sup>(20)</sup>. Contamination of water facilities was observed but no bacteriological assessment of the water was performed<sup>(1)</sup>. This evaluation is possible, however, as it was accomplished in the Tufts Mound Bayou Health Project Community Survey<sup>(14)</sup>.

The INCAP group and others did many studies relating diarrhea to malnutrition, particularly kwashiorkor<sup>(1, 11, 17, 28, 30)</sup>. Diarrhea was noted to be both a precursor and concurrent problem of malnutrition as well as exacerbating existing health problems or lowering the resistance to other illnesses. One of the most interesting findings was the observation of sugar intolerance in over one-third of the children with diarrhea and protein-calorie malnutrition or kwashiorkor<sup>(19, 4)</sup>. After specific diet therapy, almost all had cessation of diarrhea and return of sugar absorption. No pathogenic organisms were recovered from these children. DAMMIN<sup>(7)</sup> also found that children with malnutrition and diarrhea did not have pathogenic bacteria, but they did, however, have abnormally large populations of bacteria not recognized as bacterial pathogens.

The INCAP group also studied diarrhea in relation to infant weaning, aside from general malnutrition. In Guatemala, cases of diarrhea were found to cluster within a 12-month period from six to 18 months, coinciding with the beginnings of weaning. The diarrhea attack rate for infants five months of age was 18 per cent and then jumped to 99 per cent for one-year olds; by age one year, each child had an average of four attacks<sup>(31)</sup>. GORDON called this type of diarrhea "weaning diarrhea," so named by PARK and HOLT in 1902 and it is beginning to gain acceptance again today<sup>(32)</sup>. While there is an important linkage to protein-calorie malnutrition, weaning diarrhea also occurs in societies with abundance of high-quality protein<sup>(33)</sup>. The many correlations, however, of weaning diarrhea to malnutrition led BAUCH<sup>(1)</sup> to claim that weaning diarrhea should be identified as a distinct epidemiological entity among the many diarrheal disorders.

In Guatemala, the INCAP group did not gather data on specific infant feeding, such as, preparation and contents of bottled infant feedings. In their environment, milk was found to be inconsequential<sup>(1)</sup>. Bottle feeding is of increasing importance in Panama and other developing countries where, in spite of public health efforts to encourage breast feeding, there seems to be an increasing number of babies being bottle fed at earlier ages<sup>(6, 34)</sup>. According to a recent INCAP study, nutrition remains a problem in Panama: 60.7 per cent of children under five years suffer

from mild to severe malnutrition<sup>(12)</sup>. Studies already cited show this condition greatly influences development, course, and type of diarrheal disease. Therefore, bottle feeding and malnutrition have the possibility of being provocative study topics, but they need to be observed in relation to other factors thought to influence diarrhea before incorporation into a larger project.

The objective of the pilot study now being reported was to observe and relate various factors in the young children's environment which might influence specific types of diarrhea. The two additional environmental factors chosen for observation were (1) habits and activities in relation to preparation and contents of bottle feeding, and (2) health status. Results of this pilot study conducted in July and August 1970 will be considered in the planning of the future more comprehensive study of diarrhea in Panama.

### Methods

The target population was children who went to a health facility for treatment of diarrhea. They were considered to have diarrhea if diagnosed so by the health facility physicians, using the criteria cited in the introduction. If children were chosen for two reasons: accessibility of the child and family, and evaluation of each child's recorded health data in the different health facilities. Three locations were chosen for study: "Cuatro Urgencia" (emergency room ward), "Sala de Lactates" (medical ward), both in the Children's Hospital, and "Consultorio Pediátrico," a pediatric health clinic of the Childrens Hospital in San Miguelito. San Miguelito is a government low cost housing community near Panama City, built nine years ago for low to middle income families. The population utilizing these government supported facilities does not represent the general population of Panama City because higher income groups use private facilities.

Over a three week period, information was obtained from two sources: (1) a total of 70 medical records including the children's records of the families interviewed from the three health facilities, and (2) a total of 13 personal interviews completed with mothers of children from one of the three health facilities.

There was no set schedule for the hospital interviews; mothers visiting their children were asked to be interviewed. Only one mother refused due to a busy schedule. Nursing personnel in the San Miguelito Health Center were able to take the investigator to four homes in which there was one or more recent cases of diarrhea.

Interview data was collected on the child's general past and present health status, including incidence of diarrhea and other health problems, preparation and content of the main food elements, and other environmental data. Some questions

were slightly modified during the course of the study so that all percentages are not calculated on answers from the total group. The contents of the questions are easily discernible from the tables presented. Health record data were collected and presented in table form as well.

For comparative purposes, numbers of children in the emergency room ward with the two most common illnesses, pneumonia and diarrhea, were noted at intervals during the three weeks of investigation. Information was gathered by actual head count between 8 and 9.30 a.m. Due to the crowded conditions, health records and statistics were unavailable on the many children who came to the hospital emergency room with diarrhea but were not sufficiently ill to be placed in the emergency room ward and so were treated and released immediately. This group, however, will decrease due to a policy change which now directs them first to a health clinic and then to the hospital only if necessary. This action will increase the health clinic case rate which, at present, the physicians in the health clinic report as being very low (two to five cases daily in July).

**Results**

During the three weeks in August when data was collected, no unusual trend of diarrheal disease was noted.

A vital epidemiologic factor in acute diarrheal disease is the nutritional state of the population at risk. Panama's malnutrition problem is reflected in the sample (Table I) where the majority of children can be diagnosed as malnourished on the criteria of low weights<sup>(12)</sup> and low hemoglobin<sup>(13)</sup>.

TABLE II. Health Clinic Record History of Six Children seen in Four Homes in San Miguelito.

Age of Child with Diarrhea (months)	No. Visits to Health Clinic		Many Illnesses and below 16th Percentile on Growth Chart <sup>(20)</sup>
	Total	for Diarrhea or Parasites	
28	3	2	yes
1	2	2	yes
45	13	2	yes
11	17	6	yes
36	38	2	yes
36	53	5	yes

As seen from Table III, the frequency and duration of diarrhea and other illnesses also indicate chronic health problems. Almost half of the families report the child as having diarrhea one month or more. Although the children receive treatment and medication for diarrhea, they apparently do not reach full recovery. One possible explanation may be medications containing antibiotics, such as Kaomycin, Penicillin, Kantrex, Antidiarreica, or Streptomagma, usually prescribed in the three health facilities. As stated in the introduction, some of the antibiotic medications are capable of producing diarrhea, or perpetuating the existing diarrhea.

The figures in Table IV describe general living conditions of the families interviewed. While none

TABLE I. Health State of Children with Diarrhea.

Location of Child	INCAP Growth Chart 16th Percentile <sup>(21)</sup>		Normal Hemoglobin for Panama <sup>(22)</sup>		Stool Exam for Parasites	
	Below	Above	Below	Normal	Negative	Positive
Medical Ward	12	1	5	5	4	4
Emergency Room	27	11	4	4	1	*
San Miguelito	5	1	*	*	*	4
Total	44	13	9	9	5	8
Total Number Charts with Information	57		18		13	

\*No examination noted.

The six children seen in San Miguelito homes who attended the health clinic in that community appear to have chronic health problems as revealed from their health clinic charts (Table II). Once acquired, diarrhea seems to be a chronic problem related in general to poor health status.

of these figures alone has been proven to be a contributing factor to diarrhea, when coupled with methods of performing certain activities of daily living in the home environment, certain interacting effects could contribute to the spread of disease. For example, if the water and food are



TABLE III. History of Illness of Fifteen Children\* with Diarrhea in Thirteen Families Interviewed.

	Percentage
Child with diarrhea has many colds	71
Previously treated for diarrhea or parasites at health facility	81
Previously medicated for diarrhea	81
Received medicine for diarrhea from health facilities if ill	100
Other children in house ill with diarrhea during the last month	43

\*Two-thirds of these children are under one year of age.

TABLE IV. Environmental Conditions of the Thirteen Families Interviewed.

	Percentage
Water Outside	85
Toilet outside	93
Pets present	77
Lizards seen in house	57
No refrigerator	77
Child sleeps with others	50
Mother absent during day	43
Number of occupants 4 to 8	62
9 to 14	38
Number of rooms 1 to 2	69
3 to 4	31

properly stored in the home, the outside piped water and lack of refrigeration are not health threats.

On home visits, evidence was noted of the many possibilities for direct and indirect transmission of organisms. These possibilities seem due mainly to storage and preparation of water, milk, and other foods used in bottle feeding of the child.

When the water supply was outside, as most were, all families had arranged some means for keeping drinking water available inside the house (Table V). Contamination by air and use of a common cup are two of the possibilities for disease spread. As noted earlier, earthenware jars used for storage in Guatemalan homes appeared contaminated; the Panamanian containers and earthenware jars are probably an equal hazard.

Even when the mothers said they changed the water daily, questions can be raised as to if and how the jars were cleaned and how the water was changed. Some of the jars are quite large and not shaped for easy cleaning since they have a large rounded base and small funnel opening at the top. The potential threat of contaminated water would not be as great if the water for the baby was boiled.

TABLE V. Water Supply in Thirteen Homes

	Percentage
Public water supply	93
Water outside house	85
Jar of drinking water in house	100
Jar uncovered	17
Jar on floor	9
Common drinking cup for jar	33
Water changed daily	100

With infants under six months, the method and content of feeding appeared to be known and controlled by the parents. But as the child became older, parents seemed to exert less control as foods and activities became more complex, such as eating fried foods, being fed by someone other than the mother, eating and playing on the floor or outdoors. Results, therefore are concentrated only on the infants feeding up to six months, as many of the older children's eating activities would need to be more carefully controlled or they would seriously limit study results.

In the thirteen families interviewed, all of the children under two years of age were transferred from breast to bottle feeding before the minimum recommended time of six months. This action alone does not constitute a health hazard, but home activities involving storage, preparation, and content of the bottle feeding provide many opportunities for organism transmission. As noted in the present study, some examples of cultural practices capable of transmitting organisms are: using unboiled water in the bottle, and adding cereals which are often cooked long before use and left uncovered at room temperature. Another practice is using the same partially filled bottle for a second feeding if the bottle was not already emptied.

Type of milk used also may present problems; almost half of the mothers used liquid milk but three out of five of those using liquid milk did not have a refrigerator. One mother visited used fortified nonfat dry milk donated by the USA which is packaged in a cardboard carton. This carton cannot be resealed as well as a metal can;

cartons were seen opened and uncovered in some homes. Since some animals, especially lizards, commonly found in many houses, are now known to harbor various organisms such as Salmonella, there is the possibility of introducing pathogens directly into the dry milk. There is also a possibility, as mentioned in the introduction, that dry milk can be contaminated in the production process.

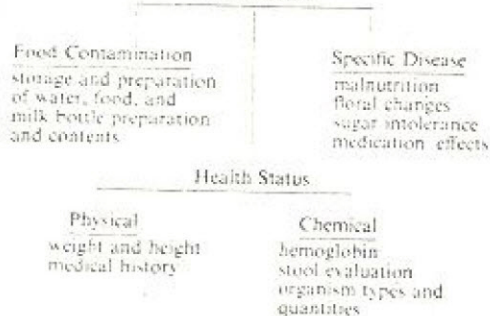
**Discussion**

These observations suggest many interesting possibilities for identifying and relating various internal and external environmental factors associated with infant diarrhea. There are possibilities for direct or indirect transmission of organisms (pathogenic or nonpathogenic) by means of storage, preparation and content of the main food elements used for infants. Yet diarrhea also appears to be involved with poor health status associated with malnutrition and other specific diseases.

Thus, in a future study, the possibility exists for diagnosing the specific type of diarrhea (micro-organism or physiological imbalance) and directly relating it to additional environmental factors of poor health status, food contamination from specific microorganisms, or specific disease.

**Environmental Factors Associated with Diarrhea.**

**DIARRHEA**



On the basis of this pilot survey of thirteen family interviews and seventy record reviews from three different areas, the following recommendations are suggested for more extensive study:

1. Because of the importance of medical and nutritional history and the complexity introduced from changes in feeding and activities of infants after six months of age, begin collecting data on normal newborns and follow them for at least six months to one year.
2. Obtain nutritional parameters such as hemoglobin, weight, height, and sugar intolerance, if possible, so as to be able to relate the extent of malnutrition to the specific type of diarrhea.
3. Collect and analyze samples of the water, cereals, and milk (dried and liquid) in the home to

see if they serve as reservoirs for pathogens or massive doses of organisms normally not pathogenic.

4. Collect and analyze stools for pathogenic and nonpathogenic organisms—bacterial, viral, and fungal, and perform quantitative studies on these organisms found.

5. Enlarge the personal interview used in the previous Panama study to include additional external environmental information (see appendix). The interview could best be completed in the home and then appropriate samples could be collected at that time. If it is not possible, however, to extend the project to this extent, the interview or even portions of it could be used in a clinic or hospital situation, as were the previous forms of Kourany and Vasquez.

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APPENDIX

It is necessary that personal interviews be easily and quickly administered and completed. A short form, therefore, was designed which incorporates questions concerning factors thought to contribute to the presence of diarrheal disease. In agreement with the first recommendation, the design focuses on infants up to six months of age.

INTERVIEW

Factors Influencing Diarrhea  
(Infant under 6 mo.)

Name of Mother (Person Interviewed): .....

Name of Child: .....

Address: .....

Age: .....

Hospital Number: .....

Health Clinic Number: .....

Weight: .....

Height: .....

Hemoglobin: .....

A. HEALTH STATUS

Yes	No

B. WATER FACILITIES

	1. Piped water outside the house.
	2. A jar for drinking water is located inside the house.
	3. Jar is covered.
	4. Jar is not placed on the floor.
	5. Group has a common drinking cup for the water jar.
	6. Water in the jar emptied and fresh water replaced daily.
	7. Jar washed with soap at least two times a week.

C. ALIMENTATION

	1. Infant receives only breast milk for at least six months.
	2. Water for the infant is given in a boiled baby bottle.
	3. Water for the infant is boiled before given.
	4. Infant often given milk in a baby bottle.
	a. Refrigerator in home.
	b. Baby bottle boiled.
	c. Water boiled for milk.
	d. Powdered milk used.
	e. Powdered milk in a tin with a securely fitting lid.
	f. Cereal added to bottle.
	1) Cereal cooked for the whole day.
	2) Milk or sugar added during or immediately after cooking.
	3) Pan of cereal on the stove or table during the day.
	4) Pan of cereal left uncovered.
	g. Unfinished bottles later given again to the infant.
	h. Bottles and nipples washed immediately after feeding the infant.

\*INCAP Curvas de Crecimiento and Evaluacion Nutricional.