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Seasonality in Water Related Intestinal Disease in Guatemala

by

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ABSTRACT.- Field studies in two rural communities in the Pacific lowlands have been in process since 1973 to evaluate the relationship between environmental improvements, particularly a piped water supply, and the prevalence of diarrheal diseases. An initial appraisal of the data indicates that diarrheal diseases in the tropics vary with the dry and rainy seasons. However, there are aspects of the relationship between water and diarrheal disease which still require explanation. The field studies are designed to provide further insight into these seasonal influences as well as to variations which are related to epidemic cycles, environmental factors and the range of socio-economic development in these areas.

Field studies are in progress in two rural communities in the Pacific lowlands of Guatemala to evaluate the effectiveness of measures to reduce food waste caused by intestinal disease. An objective of these studies is to determine if the installation of a piped water supply to the home will decrease the prevalence of diarrheal disease and reduce intestinal malabsorption. Only the component of the study relating to the influence of improvements in the community environment on the prevalence of diarrheal disease are presented. One basic assumption of the study is that the rate of morbidity in a community, especially for diarrheal disorders, is closely related to the sanitary conditions in the community as well as to the nutritional and socio-economic status of the population.

Acute Diarrheal Disease, especially in the less developed countries, is not clearly definable in terms of etiological agents. In the majority of cases, it is not possible to identify the infectious agent and the entity is usually diagnosed simply as diarrheal disease. The diagnosis is further complicated by demonstrable interactions between nutritional status and infection. The specific infective diseases associated with a water supply would include cholera, bacillary and amoebic dysentery, leptospirosis, typhoid and paratyphoid fevers, guinea worm, schistosomiasis, infectious hepatitis and enterovirus infections. Many classifications of water related disease have been proposed; however, the system set forth by White, Bradley and White (1972) is perhaps most pertinent for less developed countries. They classify these diseases as (1) water-borne, exemplified by typhoid and infectious hepatitis, (2) water-washed (Shigellosis), (3) water-based, percutaneous or ingested (bilharziasis, guinea worm), and (4) water-mediated through insect vectors.

The water related infective diseases encountered in the study villages are primarily to be found in the water-borne and water-washed classification, although individual cases frequently can not be identified as to etiology. Indeed, many of the diarrheas encountered are not attributable to specific etiological

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agents. Thus, one retreats to a definition based on the symptom rather than the cause. The measurement of diarrheal disease in the village population is derived from the interview of a household member through a monthly survey based on a two-week recall of diarrheal incidents for each of the family members. These incidents are defined as conditions in which there is a perceived increase in the frequency, volume and liquidity of the stools.

THE VILLAGES

The study villages are located in the western part of Guatemala in the Pacific Coastal Region. Guanagazapa is the test village in which a spring-fed chlorinated water supply has been piped to 60% of the houses. This village is at an elevation of 235 m with a variation of 65 m within the town. The town is situated at the base of an active volcano, Pacaya. The average rainfall is approximately 2,000 mm, and the average temperature is 20°C. The population is about 1,000 persons (with an average of 4.65 persons per house).

Florida Aceituno is a town of the same size population with a climate and rainfall similar to Guanagazapa. Elevation is approximately 200 m. The water supply was left unchanged in this village and water is procured from an existing source of shallow, unprotected dug wells.

Data has been collected each month since May 1972 on (a) population characteristics and census, (b) incidence of diarrheal, respiratory and other illness, (c) amount and number of days of rainfall, (d) incidence of *Shigella.* and *Salmonella* infection, (e) quantity of water consumed, (f) quality of water at the source and in household water containers, and, (g) sanitary condition of the homes and surroundings.

A large number of other variables are being studied. These include parasitology, spatial distribution of morbidity within each village, crowding, and level-of-living indices. Other studies include dietary surveys, anthropometric measurements, economic status and detailed balance studies for the evaluation of malabsorption and food wastage.

DIARRHEAL MORBIDITY

The prevalence of diarrheal disorders in tropical climates has been related to the occurrence of rainy and dry seasons. Girt (1974) has reviewed a number of studies that point to ground water contamination as a significant element in the spread of cholera, *Salmonella* infections and diarrheal morbidity. The hypothesis is that ground water that occurs near the surface can be easily polluted, and the population that concentrates their dwellings in these polluted areas is at increased risk. In rural areas, a lack of sanitary facilities and defecation in the fields results in pollution of the water supplies. The statement is essentially correct, but is too simple to explain the influence of seasonality on water related intestinal disease. White, Bradley and White (1972) caution that "the precise etiology of many diarrheal episodes in the tropics, the effects of intermittent as compared with perpetual exposure to polluted water, and many other important matters are still unknown. The common delusion that everything useful or important is already known about infectious and waterborne disease is clearly far from true, and many of the problems can well be studied in the tropics".

The interaction of nutrition and infection cannot be disregarded in considering the patterns of diarrheal morbidity. Scrimshaw, Taylor and Gordon (1968) noted the influence of seasonal factors in a study of weanling diarrhea in the Punjab, where there is a hot dry season in May and June and a hot wet season in July, August and September. Maximum diarrheal prevalence in the first year of life did

occur in the hot wet season and in the following months. Children born in spring and during the hot dry season had the lowest death rates for diarrheal disease and were predominantly breast fed at the time of major risk. They note that increase in diarrheal disease is seemingly due to a combination of seasonal risk of attack, greater dehydration when diarrhea occurs at that time, and an enhanced susceptibility due to weaning, as well as the ingestion of contaminated food.

The extensive studies made by the Institute of Nutrition of Central America and Panama on the epidemiology of diarrheal disease in children in the Guatemalan highland villages are too extensive to be discussed here. However, some findings related to seasonal and sanitation factors will be summarized.

A study of three Guatemalan highland villages showed that the seasonal peak of diarrheal disease occurs in May and June. However, the role of water is somewhat ambiguous, since common-source epidemics did not contribute materially to the major portion of acute diarrheal diseases in the communities studied. Common water sources are usual in the villages and, certainly, are frequently contaminated. However, the most frequent age for diarrheal morbidity is in the first three years of life and children at this age do not consume much water. Again, this is too simplistic an approach to water related intestinal disease because diarrheal morbidity is associated with a wider spectrum of etiology than water-borne disease. Diseases such as shigellosis are more correctly classified as water-washed diseases and are mediated through poor sanitation and personal hygiene rather than by the ingestion of polluted water. Therefore, the availability of water in sufficient quantity and convenient to the user is a prime variable. The explanation of the causation of diarrheal morbidity is further complicated by studies which show that less than half the cases of diarrheal morbidity yield pathogenic agents by present techniques.

The INCAP studies indicate that direct contact is the chief method of spread for the diarrheal diseases. The hygienic habits of children, as well as adults, in the family unit are of major importance. The availability of sufficient water to provide for basic sanitation is important in minimizing disease transmission through personal contact. The study described here includes a major effort in health education and in the promotion of the hygienic use of the piped water supply in the test village.

The multiple role of water has been noted and the relation of water to food preparation should be emphasized. Caperelli and Mata (1975) have demonstrated that tortillas offer a rich source for bacterial growth. The water used for tortilla preparation usually contains high levels of bacterial contamination of fecal origin. Cooking destroys many of the bacteria, but poor storage and handling and high ambient temperatures bring the bacterial concentrations up to precooked levels within 24 to 48 hours.

The importance of water is related to health in a number of ways beyond direct water consumption. The infectious agents were usually derived from water used in the preparation of and from the soiled hands of women preparing the tortillas. It is interesting to note that these studies were done during the rainy season when the environmental temperatures ranged from 10 to 28°C, with an average rainfall of 0 to 28 mm/day.

Mata and Behar (1975) have reviewed the results of a long-term prospective study of fetal and postnatal growth in a Guatemalan highland village. The prime role of the physical environment is emphasized by their statement that "traditionally, deficient diets have been recognized as main determinants of growth failure in children of developing nations. Infection, however, has emerged as an important factor, often as important or more important than the particular diet of a region. Due to deficient sanitation, crowding, poor housing and chronic malnutrition, infection is present at all stages of human growth, including the period of fetal development."

THE FIELD STUDY

Diarrheal morbidity in the villages in our study follows the course that has been well recognized in the less developed countries. Cases are concentrated in infants and young children and the incidence declines with advancing age. The diarrheal morbidity rates shown are for children less than six years of age. The disease is endemic, however there are occasional fluctuations in village levels. It is difficult to say whether these fluctuations represent an actual epidemic or represent variations within the cyclic occurrence of the disease.

Figure 1 shows the seasonal occurrence which is associated with the rainy and dry seasons. The period of May through October is the rainy season and November through April corresponds to the dry season. The increase in diarrhea observed in both communities during the period of April through July corresponds to the period of the year when the average monthly rainfall is heaviest. During 1973, the average rainfall was particularly severe and this may have influenced the high rates of diarrhea observed in both communities during that year. However, the difference observed between 1973 and 1974 may also be a reflection of normal variations which have been described (Scrimshaw, Taylor and Gordon, 1968). Diarrheal disease displays the same fluctuation endemicity as seen in other common infectious diseases, especially those of childhood.

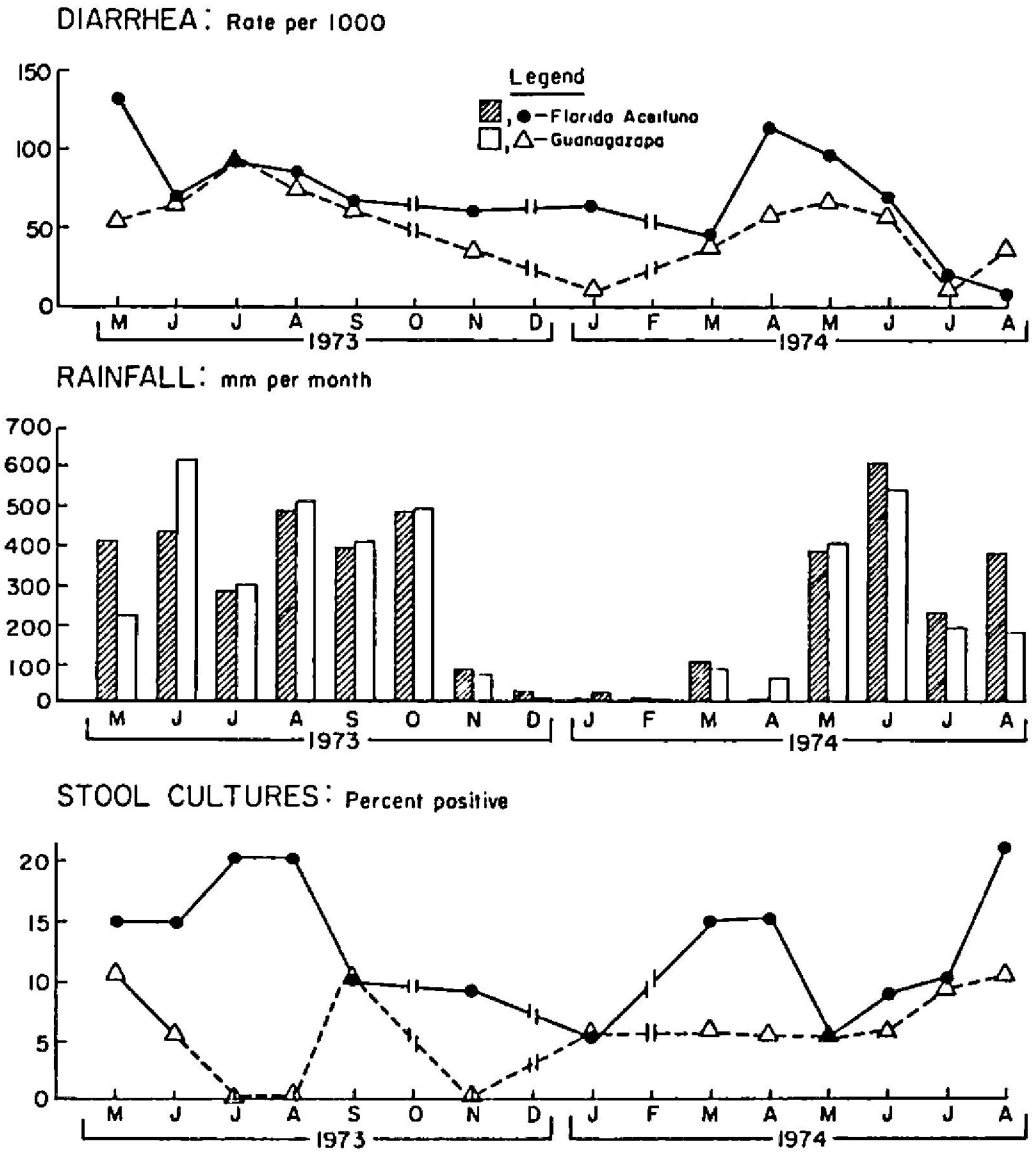

Fig. 1. Seasonality of rainfall, diarrheal morbidity rates, and parasite incidence.

Figure 1 also shows the prevalence of enteropathogens capable of causing diarrhea. The presence of pathogens and diarrheal morbidity has been evaluated by collecting monthly stool cultures from children up to four years of age in each community and examining for Shigella and Salmonella. Stool samples for *Salmonella-Shigella* are done monthly on a sample of 20 children in each village. In addition, thirty children are chosen, at random, each six months, for a complete microbiological survey of their stools.

There was a higher percentage of isolations of *Shigella* and *Salmonella* in the village population of Florida Aceituno, where the water supply is derived from unprotected, shallow dug wells. In this village, the increased prevalence of positive stool cultures was also associated with the beginning of the rain season. Though, there are climatological similarities between the two villages, the soil in Floridá Aceituno, which is located in a tropical woods area, remains saturated for a longer time after a rainfall than the soil in Guanagazapa. The sum of these findings makes it tempting to hypothesize that there is an increased opportunity for the spread of fecal material on the ground in Florida Aceituno after a period of heavy rainfall with consequent environmental contamination of the water supply. The association between diarrheal morbidity, positive stool cultures and rainfall is less apparent in Guanagazapa, with its improved piped water supply, than in Florida Aceituno.

OTHER FACTORS

"Acute diarrheal disease" remains a complex entity which is not explainable by a single or even several etiological factors. The full scope of the current field study cannot be dealt with in this presentation. Preliminary data indicate that diarrhea represents the most sensitive indicator of total morbidity in these communities. The prevalence of diarrheal morbidity follows that in other tropical regions and results in: (a) increased prevalence in the 0-3 year age group, (b) seasonal variations with an increase in the rainy season, (c) frequent association of diarrheal and respiratory disease.

Some of our preliminary findings were less expected. In 1972-1973, rectal swab examinations were performed on 664 persons of all ages in Guanagazapa and 529 persons in Florida Aceituno. Only 47 persons in Guanagazapa and 46 persons in Florida Aceituno were free of protozoa and helminths with multiparasitism common. However, the prevalence of diarrhea did not correlate with either the presence or the moderate intensity of intestinal parasitism found in most of the population of both communities.

At this stage of the study, there is no clear demonstration of any reduction in diarrheal morbidity associated with the introduction of the piped water supply (Fig. 2). Further, the important variable of water use must be considered. The household consumption of water is measured. However increasing the availability of water does not mean that people will efficiently utilize the water for improving household and personal hygiene. This objective can only be achieved through a program of education.

A fuller explanation of this relationship between water and health will require a more extended time period and require the measurement of a number of variables including interactions of infection, nutrition, seasonality, epidemic events, socio-economic development, and environmental conditions.

Further efforts to explain these interactions are being pursued. Belcher's Level of Living Scale (1972) is being applied to the two villages to assess the correlation of socio-economic factors with diarrheal morbidity. In addition, there are ongoing studies of geographic determinants of morbidity within the study communities. Map coordinates are used to identify individual houses and zones within each village.

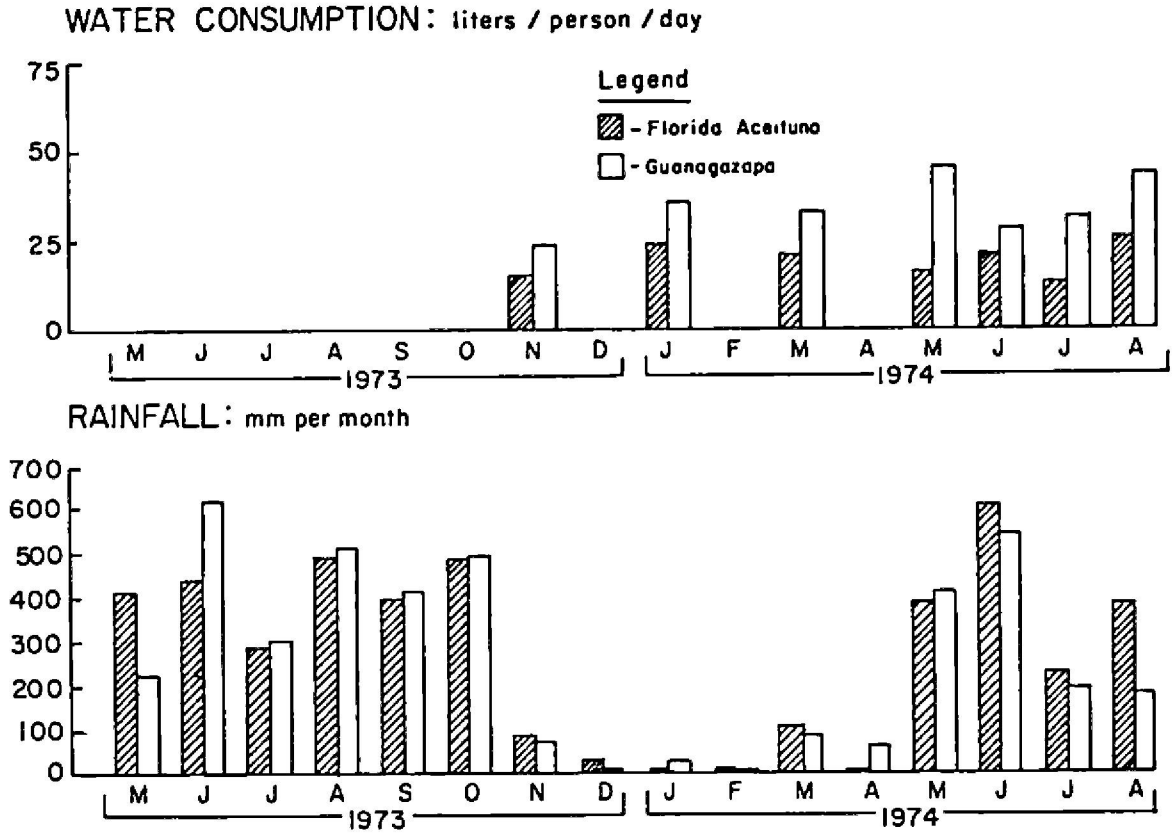

Fig. 2. Seasonality of water consumption and rainfall.

Preliminary results indicate that the prevalence of diarrhea varies from one part of the village to another. The map coordinates are used to evaluate the zones where the homes with piped water supplies predominate and also where other intra-village variables of interest are being measured.

CONCLUSION

A superficial examination of the data could lead to the conclusion that intestinal morbidity is essentially a seasonal phenomenon influenced by rainfall and temperature through contaminated and inadequate water supplies, fecal soil contamination, and improper food handling. However, we believe that this is too simplistic a model and other variables such as water usage patterns, cultural influences, and housing contribute to intestinal morbidity which is often reflected in a seasonal pattern.

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