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Risk Factors for Acute Childhood Diarrhea in the Highlands of Chiapas, Mexico: A Strategy for Intervention¹

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A case-control study was conducted in the highlands of Chiapas, Mexico, to identify factors associated with acute diarrhea in children less than six years old. The study found that the diarrhea attack rate among the children surveyed during three weeks in the month of August (the peak diarrhea season) was approximately 30%, and that children whose mothers had diarrhea were especially likely to contract the illness themselves. The methods employed could prove relevant to studies in other areas, and the results obtained could provide the basis for more detailed study of the area involved—and for preventive action.

Worldwide, diarrheal diseases account for an estimated five million deaths per year among children under five years old (1). In recent years, oral rehydration therapy (ORT) has come to be recognized as offering an effective way to reduce this mortality, and has come to be used by the governments of many developing countries as the mainstay of acute diarrhea mortality control efforts. However, ORT's role in preventing deaths from dysenteric or persistent diarrhea, as well as in controlling diarrheal morbidity, is limited (2); and so other strategies for diarrhea control interventions need to be considered.

Feachem (3) has reviewed some alternative intervention methods and has grouped them into five general categories relating to maternal health, child health, immuno- and chemoprophylaxis, interruption of transmission, and epidemic control. In any target community it is important to empirically evaluate the feasibility of such intervention methods because diarrhea morbidity is often influenced by unique local factors. These factors include behavioral and cultural practices, host factors (such as nutrition, immunity, and antibiotic exposure), environmental conditions, and differences in the prevailing etiologic agents of diarrhea. Knowledge of these factors as they affect a specific community can help to identify the most appropriate and effective intervention strategies.

MATERIALS AND METHODS

In the summer of 1987 we conducted a community-based case-control study within the highland agrarian community

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of Mitontic in the state of Chiapas, Mexico. The investigation was performed in preparation for a series of studies in this general area of Mexico that were directed at making a detailed examination of the various determinants of diarrhea—including etiologic agents as well as host-related, environmental, cultural, and behavioral factors. The study reported here sought to identify specific local factors influencing the occurrence and transmission of diarrhea among children in Mitontic. More broadly, we felt that this community was representative of other parts of Mexico and Central America with similar environmental and cultural patterns, and hence that intervention strategies found appropriate for it would prove applicable to other areas.

The Study Community

The study community's residents, numbering 5,960 according to a 1985 government estimate, consisted predominantly of Mayan Indians speaking the Tzotzil dialect. The community included a main village (also called Mitontic) together with several outlying villages or hamlets (*parajes*). A health clinic (under the jurisdiction of the Chiapas District II Health Center of the State-Coordinated Public Health Services) was situated in the main village, where much of the field work was performed.

Demographic Data Collection and Diarrhea Surveillance

A census was conducted to obtain current demographic data on the population of the main village (Mitontic) and two satellite *parajes*, Xoc'ton and Choco'. An aerial photograph of the villages was taken, and this was used to construct a map of the community. Each house identified from the map was numbered, and

the name, age, and sex of each household member was obtained. Deaths from all causes and deaths due to diarrhea during the year preceding the census were recorded. Unoccupied houses were also numbered (during the study period nearly half the houses were temporarily unoccupied because of cyclical migration by residents following patterns dictated by agricultural practices or religion).

To help identify new diarrhea cases and estimate diarrhea incidence in the community, we divided the village into 13 sectors containing about 20 households each. In every sector a mother fluent in both Spanish and Tzotzil was recruited. These sector volunteer mothers were trained to visit each household in the sector daily and identify new cases of diarrhea in children less than six years old. They were also taught how to administer oral rehydration therapy to children with diarrhea.

In order to compare the number of children with diarrhea who were identified this way with the numbers of diarrhea cases seen at the Mitontic rural health clinic, we examined the health clinic's records for the month of August in the years 1985, 1986, and 1987.

The Case-Control Survey

A survey of diarrhea cases in the study community was conducted for three weeks during the first part of August 1987. For purposes of this survey, a case of diarrhea was defined by the occurrence of three or more loose stools within a 24-hour period in a child less than six years old. Every time a case was detected, efforts were made to select as a control an age-matched child from the same sector who had been diarrhea-free for two weeks preceding the interview date and who lived in a household as close as possible to that of the sick child. The occurrence of three or more loose

stools on any day within three days of an episode of diarrhea was not classified as a new case but rather as part of the previous episode.

A standardized questionnaire was developed and administered to the mothers of both case and control children. The demographic, clinical, and exposure characteristics listed in Table 1 were examined. Interview teams consisting of the sector volunteer mother, a government primary health care worker, and a Spanish-

Table 1. Demographic, clinical, and exposure data collected by interviewing mothers of the children surveyed during the case-control study of diarrheal disease conducted in Mitontic, Chiapas, Mexico (August 1987).

Demographic characteristics:

Birth date of all household members
Age of all household members
Sex of all household members
Number of children per household
Mother's primary language

Clinical characteristics:

Date of onset of diarrhea
Duration of diarrhea
Occurrence of the following symptoms:
 Fever (subjective)
 Vomiting
 Blood in stool
 Cough for ≥ 3 days

Exposure characteristics:

Mother with diarrhea in the 2 weeks before interview
Milk consumption in the 2 weeks before interview
Meat (pork, beef, chicken) consumption
Source of drinking water
Distance to drinking water source
Household sanitary facilities
Kinds of animals around the house
Illness in these animals during the 2 weeks before interview
Home construction methods (concrete vs. adobe walls)
Availability of electricity
Water storage method
Garbage disposal method

speaking medical student from Stanford University visited the village every other day. The volunteer mother took the team to all the households where a child had developed diarrhea since the time of the previous team visit. In this way, all new cases of diarrhea in the entire study community were documented once every two days.

To assist with the team's assessment regarding the presence or absence of diarrhea, the team was usually accompanied by a physician specializing in communicable diseases. Whenever possible, the consistency of the stool and the presence of mucus or blood was noted. After obtaining appropriate consent, the team completed the questionnaire and collected stool specimens. It then visited the nearest household with an age-matched child for the purpose of selecting a control subject.

Statistical Analysis

Only one control subject from each household that was not a case household was included in the analyses. Since a neighborhood-matched control subject could not be found in every case, we used a matched-pair analysis (McNemar's test), when appropriate, to compare age-matched case-control pairs (4). Certain household characteristics (such as whether Spanish was spoken in the home, the type of house wall construction used, the availability of electricity, the type of sanitary facilities present, and the distance to a water source) were found to be clustered within the village. These variables could not be analyzed for an association with diarrhea by comparing neighborhood-matched cases and controls; therefore, they were analyzed separately, using only case-control pairs that were not matched by neighborhood.

Table 2. Distribution by age and diarrheal attack rate of children under six years old in the study areas of Mitontic, Chiapas, in August 1987.

Age (years)	Total no.	Cases of diarrhea	
		No.	Attack rate (%) ^a
0-1	53	25	47
> 1-2	27	15	56
> 2-5	133	23	17
Subtotal < 6	213	63	30
≥ 6	544	ND ^b	ND
Total	757		

^aDuring 3 weeks of observation.

^bND = not done.

RESULTS

Demographic Data and Diarrhea Surveillance

The census showed that the community had 757 residents and 268 homes, of which 141 were unoccupied when the census was taken (Table 2). The reported ages of the residents ranged from five days to 73 years. As Table 2 indicates, over a quarter of the residents (213) were less than six years old. Three hundred eighty-six (51%) were male. Six of 59 children less than one year old at the time of the census were said to have died from diarrhea during the preceding year, implying that infant mortality from diarrhea in this community was on the order of 102 deaths per 1,000 live births.

Although residents moved in and out of the community during the surveillance period, the total number of people present remained about the same. During this period, 63 cases of diarrhea were identified in children less than six years old. The overall attack rate in this age group was 30%, with the highest rate (56%) occurring in children between one and two years of age.

Symptoms reported among the 63 children with diarrhea included vomiting in 19 cases (30%), fever (subjective) in 23 cases (37%), upper respiratory symptoms in 20 cases (32%), and blood in the stool in seven cases (11%).⁴

Regarding diarrhea cases reported at the Mitontic Health Clinic, the number of cases reported in children under age six was 0 in August 1985, 4 in August 1986, and 11 in August 1987.

The Case-Control Survey

All 63 of the children with diarrhea cases had only one episode of diarrhea during the three-week surveillance period.

During this period, 48 control children were selected and paired with 48 of the 63 sick children. Twenty-nine of these control children were appropriately matched with the corresponding sick children by both age and neighborhood.

⁴A series of tests were performed on the fecal specimens to determine the microbial causes of the diarrhea. As a result, we obtained a collection of data whose volume and complexity justify development of a separate report, which is currently being prepared.

No significant difference was found between the average number of children living in the homes of the sick children as compared to the number living in the homes of the controls. Specifically, the average number of children living in the sick children's homes was 4.1, while the average number living in the control children's homes was 4.8.

Nearly all of the children less than two years old were breast-fed, and there was no noteworthy variation in the types of meat or vegetables consumed by the community residents. Hence, it was not possible to determine whether these factors were associated with the occurrence of diarrhea. However, it was found that certain other factors (the presence of domestic animals inside or around the residence, occurrence of illness in these animals during the two weeks preceding the sick child's onset of diarrhea, the type of water source serving the home, the kinds of water storage containers used, and garbage disposal practices) were not associated with diarrhea.

Certain other conditions (whether the household was Spanish-speaking, whether the home was made with concrete versus adobe walls, whether it was electrified, and whether sanitary facilities were present) were found to cluster in certain sections of the community. Therefore, we could not determine whether these factors were associated with diarrhea by comparing sick children with controls from the same neighborhood. For this reason, these variables were analyzed by examining only those instances where the sick child was paired with a control child matched by age but not by neighborhood. The number of such pairs for which the necessary information was available from both cases and controls was too small to draw any conclusions.

However, one variable was found to be significantly associated with diarrhea in the study children, this being a preceding

case of diarrhea in the mother. Specifically, within the 29 neighborhood-matched case-control pairs there were 11 instances in which the mother of one child in the pair had diarrhea within the two weeks preceding occurrence of diarrhea in the sick child. In 10 of these 11 instances, the mother with diarrhea was the mother of the sick child ($p < 0.05$, relative risk = 10, McNemar's test).

DISCUSSION AND CONCLUSIONS

This study was conducted during the peak local diarrhea season. As in acute outbreak investigations, only factors observable by the investigators at the time of the interviews and information obtainable by maternal recall of recent events were examined. Despite the limitations inherent in this approach, we were able to identify at least one factor associated with diarrhea. We also found that a case-control approach, which is often used to study disease in an epidemic setting, was useful in studying this endemic disease during a period when its incidence was rising.

In addition, the organization of the community into sectors, each surveyed daily by a resident mother, proved effective in obtaining a population-based estimate of diarrheal incidence and in locating enough diarrhea cases to conduct a case-control study. Indeed, estimated diarrheal morbidity was extremely high in Mitontic during the three-week surveillance period, despite the presence of a health care clinic, auxiliary health care workers, and oral rehydration therapy.

During comparable periods of 1985, 1986, and 1987 the number of children seen at the health clinic for diarrhea was a small fraction of the number of children with diarrhea documented by our community-based study. Hence, with respect to diarrheal disease the clinic seemed underutilized and did not appear

to play a major part in disease control. These observations indicated to us that the determinants of diarrhea had to be examined within the context of community behavior in order to devise appropriate interventions.

Several community-based studies of acute diarrhea were conducted in the 1950s and 1960s in Guatemala (5-8) in areas ethnically and ecologically similar to the Chiapas highlands. However, most of these studies used a descriptive approach to speculate about variables associated with diarrhea, and hence did not provide an empirical basis for designing specific interventions. Elsewhere, a community-based, case-control methodology has been used in the urban slums of Dhaka, Bangladesh, to identify water sanitation practices found empirically to be associated with diarrhea (9). A follow-up randomized educational intervention study designed to promote diarrhea-protective behaviors that already existed in the households (such as handwashing before preparing food) demonstrated that such interventions did reduce the occurrence of diarrhea (10).

In the present study, the unit of observation and analysis was the individual child (as opposed to the individual household in the Bangladesh study). This approach provided an opportunity to identify at least one factor that would not have been detectable by examination of entire households. That is, we found that children with diarrhea were more likely than matched controls to have mothers who experienced diarrhea within two weeks of the occurrence of diarrhea in the sick child. Since we did not culture the mothers' stools, we do not know if each sick mother and child shared the same etiologic agent, nor do we know the routes of transmission of the infection. However, the observed temporal relationship of the diarrhea episodes suggests that a specific interven-

tion helping to prevent childhood diarrhea could simply be a recommendation that mothers who develop diarrhea wash their hands after defecation, especially before preparing food or breast-feeding children. Such a specifically directed handwashing recommendation might be more effective in assuring compliance than broadly applied handwashing recommendations. In general, however, it seems clear that additional studies will be needed to identify specific behaviors in the mother-child relationship that influence the development of diarrhea in the child.

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Listeriosis Documents Available

The International Phage Typing Center for *Listeria* (Pasteur Institute, Paris), has compiled a literature review on human listeriosis and *Listeria* in food and a list of references on *Listeria*, both updated through 1988.

The literature review covers such aspects as incidence, inhibition, detection, and origin of food contamination. The annual list of references comprises 417 entries as well as an author index and a subject index.

Both documents are available on request from: Food Safety Unit, Division of Environmental Health, WHO CH-1211 Geneva 27, or from Dr. Joyce Rocourt, Unité d'Ecologie bactérienne, Institut Pasteur, 28, rue du Dr Roux, F-75724 Paris Cedex 15. (Enclose a self-addressed label with your request.)

Source: World Health Organization, *Wkly Epidemiol Rec* (65)7750, 1990.