CHAPTER FIVE

EPIDEMIOLOGIC FINDINGS

Provincial Level

This presentation of the epidemiologic findings begins with a review of the morbidity experience of five Dominican provinces over a five-year period of time, 1976 through 1980. The provinces studied border each other and form a line of increasing distance from the worst wind damage caused by the hurricanes (Table 5-1). All the provinces are rural, and have an economy based on subsistance agriculture and some cash crops. Of the sixty months of data investigated, forty-four months were before the hurricanes, and the remaining sixteen months followed the disaster. The five months immediately following the hurricanes were examined for morbidity levels in comparison to the levels established by the remaining fifty-five months of the study period. The data stem from incidence reports, as described in the previous chapter.

The diseases examined were malaria, typhoid and paratyphoid fevers, hepatitis, gastroenteritis, and measles (rubeola). With the exception of malaria, the results are discussed below, following a brief description of each disease as it presents in the Dominican environment. No significant post-disaster increase in malaria was noted apart from the continued national increase in the disease since the demise of the Pan American Health Organization malaria control program several years prior to the hurricanes.[1]

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[1] Unpublished work by Dr. Amiro Pérez Mera, Dominican National Statistics Office, shows a nationwide increase in malaria of 890 percent between 1976 and 1980.

Table 5-1

Peak Monthly Disease Incidence (per 100,000 Inhabitants) in the Five-Month Post-Disaster Period, by Province (a)

Province	Approx. Mean Distance From Perimeter, Eye of Hurricane (b)	TYPHOID & PARATYPHOID Peak rate	#(SD) from $\bar{X}$	HEPATITIS Peak rate	#(SD) from $\bar{X}$	GASTRO-ENTERITIS Peak rate	#(SD) from $\bar{X}$	MEASLES Peak rate	#(SD) from $\bar{X}$
San Cristobal Pop. 408,228	0 km	0	-0.5	13*	4.7	664*	10.1	114*	14.9
Peravia Pop. 152,341	0 km	4	1.6	19*	3.3	990*	6.6	92*	7.0
Azua Pop. 67,500	10 km	6	-0.2	31*	3.6	1354*	5.7	34	1.0
San Juan Pop. 235,424	28 km	12	2.3	18*	6.1	432	2.1	29*	3.4
Estrelleta Pop. 67,005	55 km	64*	10.9	27	2.7	345	1.9	16	0.5

(a) Malaria is not shown here. Because of the cyclical nature of the disease in the Dominican environment, the three standard deviation test was not applicable.

(b) Crowding in refugee centers increased with proximity to the eye of the hurricanes.

(*) Statistically significant by test of three standard deviations (SD) from the mean.

Typhoid and paratyphoid fevers are actually two diseases. Because they are clinically almost identical and the Dominican Republic generally lacks the availability of laboratory testing to distinguish between them, they are statistically placed together. Typhoid and paratyphoid fevers are bacterial diseases which center in the gastro-intestinal system and typically cause high fever, muscular pain, headache, malaise, and anorexia. The usual untreated fatality rate is

about ten percent.[2] Transmission of the typhoid bacillus is varied: fecal-oral, urine, water-borne, or in contaminated food. The incubation period is seven to twenty-one days, with symptom duration of seven to fourteen days. These diseases are typically treated with the common antibiotics chloramphenicol and ampicillin. A typhoid vaccine also exists, which lends about sixty percent immunity, and must be given in a series of two injections several weeks apart, followed by boosters three years later. Typhoid and paratyphoid fevers are relatively highly endemic in the Dominican Republic, presumably due mostly to the country's poor sanitation systems.

Infectious hepatitis is a viral liver disease that is transmitted by several routes: fecal-oral, urinary, water-borne, direct contact, and food contamination. The incubation period ranges from fifteen to fifty days, usually around a month. The clinical presentation of the disease may last from a week to several months and includes jaundice, fever, malaise, anorexia, nausea, and abdominal discomfort. Fatalities are rare, but general weakness may last for several months after the jaundice disappears. Almost all hepatitis in the Dominican Republic is assumed to be type A, but laboratory testing to distinguish it from type B, or non-A, non-B, is generally not available. Hepatitis is relatively highly endemic in the Dominican Republic for reasons similar to those of typhoid and paratyphoid fevers.

Gastroenteritis is operationally defined in the rural Dominican diagnostic system as any acute, short-term gastro-intestinal infection

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[2] Abram S. Benenson, Ed.,: Control of Communicable Diseases in Man, USA: American Public Health Association, 1975, p. 350.

presenting as vomiting, diarrhea, and abdominal pain with little or no fever. It may be caused by a variety of viral, bacterial or protozoal pathogens, and is usually transmitted by the fecal-oral route. The diarrhea caused by gastroenteritis may be quickly fatal to undernourished children and infants, because of rapid dehydration. The disease is widespread in the Dominican Republic, particularly among children.

Measles is a highly communicable viral disease which causes high fever, bronchitis, and a characteristic rash. Complications can be serious and include pneumonia, encephalitis, and otitis media (ear infections). The disease, which is primarily transmitted by airborne droplets, may have a mortality rate of five percent to ten percent in developing countries, apparently depending largely on nutritional levels. Measles has been problematic in the Dominican Republic for some years, and has not been highly responsive to vaccination programs to control it.

Results

The following discussion on the results of the provincial-level study is based on the data presented in Table 5-1, page 72. In addition to the disease incidence data, the table shows the approximate mean distance of the majority of the population of each province from the perimeter of the eye of Hurricane David. Although not quantified, there is considerable evidence that, in the rural areas, population crowding into refugee centers was highly correlated with proximity to the eye of the storm. The importance of this is discussed in the text below. A

graph of the incidence data is presented in the text for one province for each disease. The graphs for the provinces not shown can be found in the appendix. Each graph presents the incidence data in both their crude forms, and in the form of per 100,000 population rates. The reader should remember that the data represent monthly, not yearly figures.

In only one of the five study provinces was there a statistically significant post-disaster increase in typhoid/paratyphoid fevers (Figure 5-1). This province, Estrelleta, is the furthest away of the five provinces from the most destructive winds of the hurricanes, but still received high winds and widespread flooding. The highly significant typhoid fever increase in Estrelleta, at its peak a twenty-eight fold rise above the fifty-five month mean, started almost immediately after the hurricanes and continued through the fifth post-disaster month. Compared to other tropical countries, the Dominican Republic has a somewhat higher than normal endemic incidence of typhoid and paratyphoid fevers: In 1978 there were 17.9 cases per 100,000 population, as compared to a Caribbean average of 6.0 cases that year.[3] At its peak in Estrelleta, the rate reached sixty-four cases per 100,000 per month, or a very high 768 cases per 100,000 if annualized.

Four of the five provinces experienced increases in hepatitis which were significant at the 0.001 level. Figure 5-2 graphs the most striking example, in the province of San Cristóbal, over the sixty month period. The increases noted were between three and 6.2 times the fifty-

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[3] Pan American Health Organization: Health Conditions in the Americas 1977-1980, Washington, D.C., Scientific Publication No. 427, 1982, p. 337.

FIGURE 5-1

TYPHOID AND PARATYPHOID FEVERS
1976-1980

PROVINCE: ESTRELLETA

1979 Population:67,005

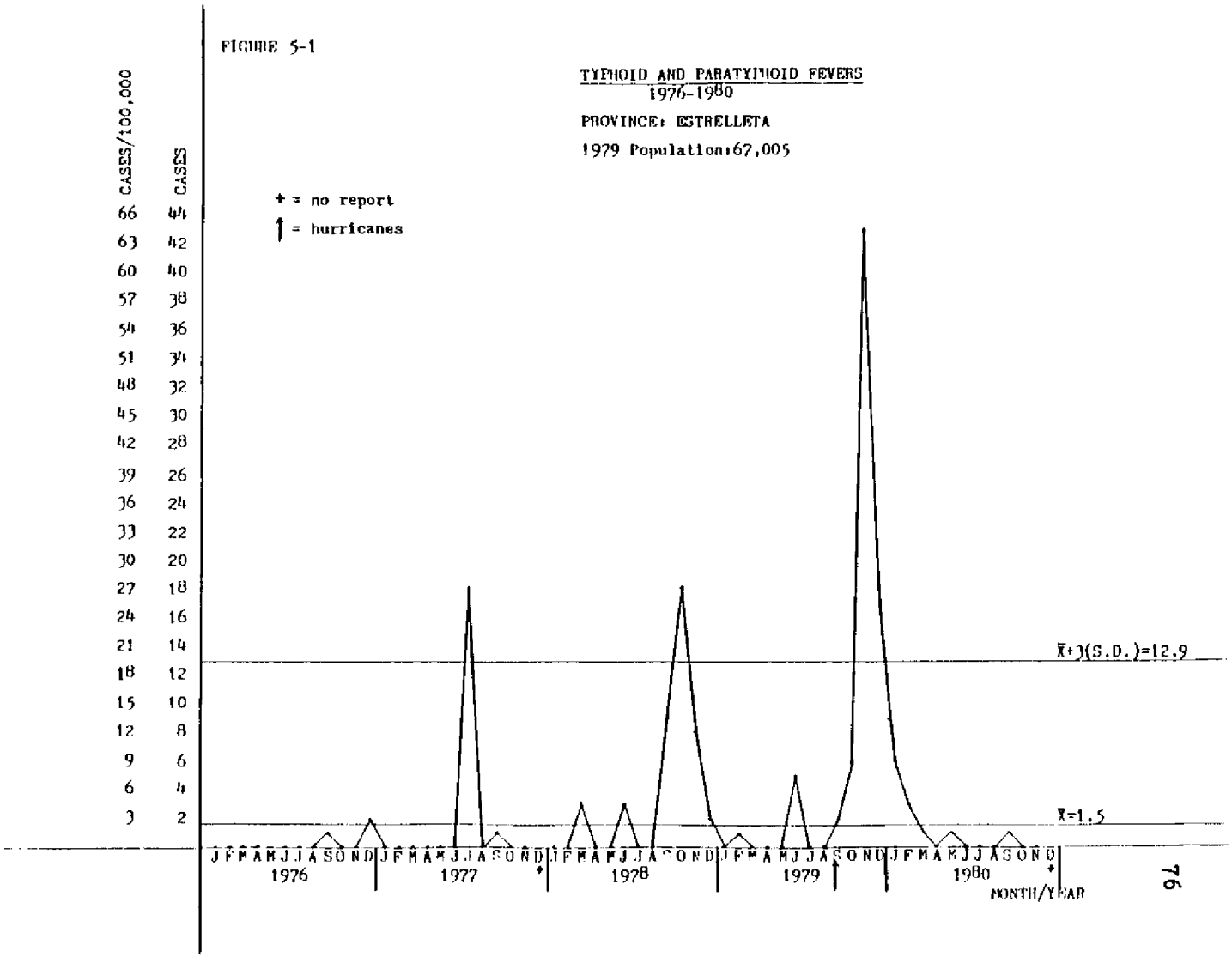


FIGURE 5-2

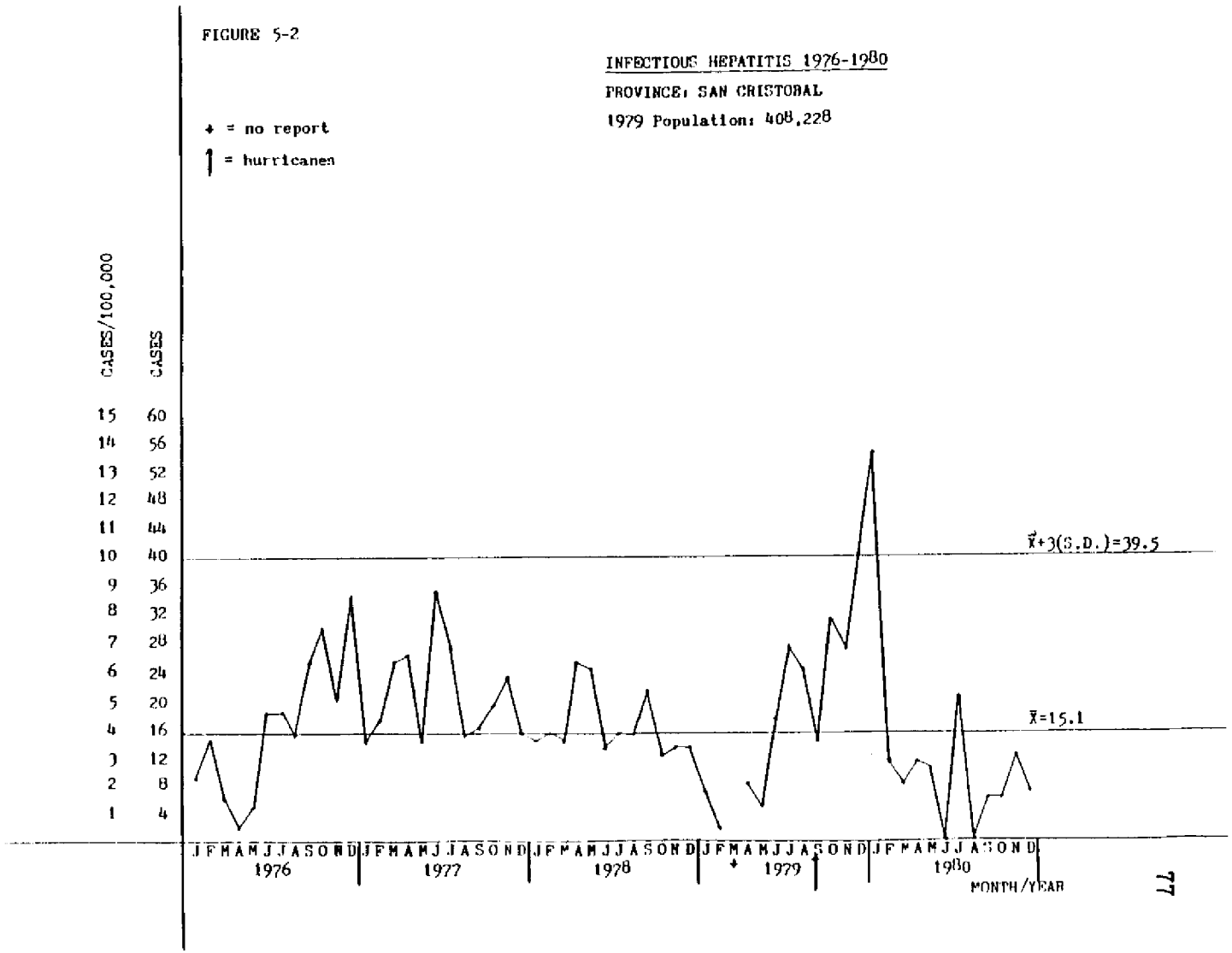
INFECTIOUS HEPATITIS 1976-1980

PROVINCE: SAN CRISTOBAL

1979 Population: 408,228

♦ = no report

↑ = hurricanes



five month mean and peaked between three and five months following the hurricanes. Hepatitis has a relatively high endemic level in the Dominican Republic, with a 1978 national rate of 57.0 cases per year per 100,000 population.[4] The post-disaster peak rates ranged up to 31.1 cases per 100,000 per month in Ázua, or approximately 373 cases per 100,000 if figured on an annual basis. Unfortunately, an age breakdown was unavailable for these data, to help determine whether it was primarily children who experienced the increase in the disease.

The high gastroenteritis endemicity in the Dominican Republic gave way to short-lived but epidemic level[5] increases in three of the five provinces (best example: San Cristóbal, shown in Figure 5-3).

Measles also showed statistically significant increases in three out of the five study provinces (example San Cristobal in Figure 5-4). The peak measles incidence in the province of San Cristóbal following the hurricanes was at a per 100,000 persons rate of 114 cases per month, or a twelve-fold increase over the national average, to an annual rate of 1,368 cases. The same increase signified a nine-fold rise over the San Cristóbal average, and Peravia experienced a similar eight-fold rise.

Discussion

Four out of the five diseases studied showed significant increases within six months following the hurricanes. These findings

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[4] Ibid: p. 329.

[5] "Epidemic" is defined by Benenson (1975) as ". . .the occurrence in a community or region of cases of an illness (or outbreak) clearly in excess of the normal expenctancy and derived from a common or a propagated source." Op cit, Benenson: p. 380.

FIGURE 5-3

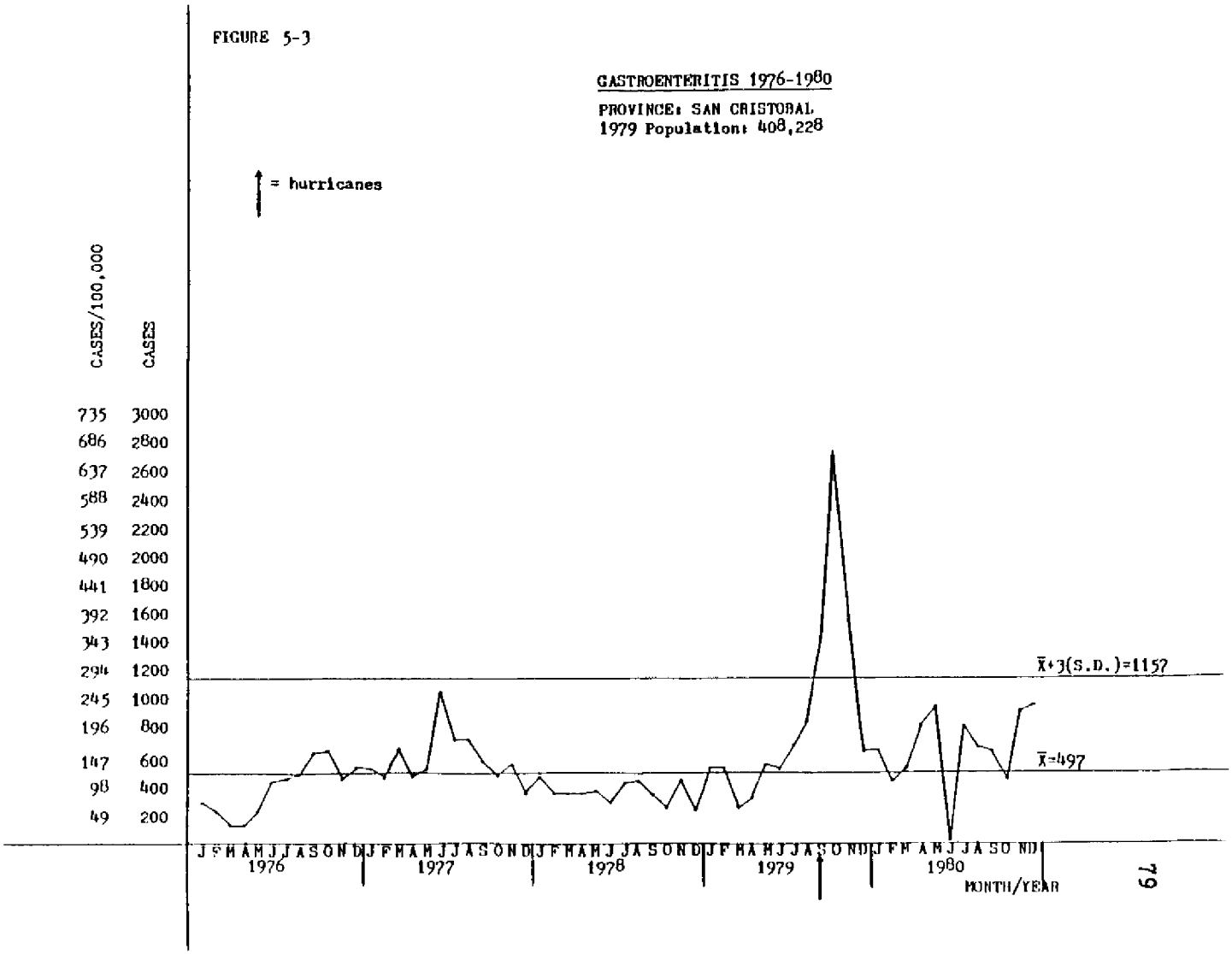
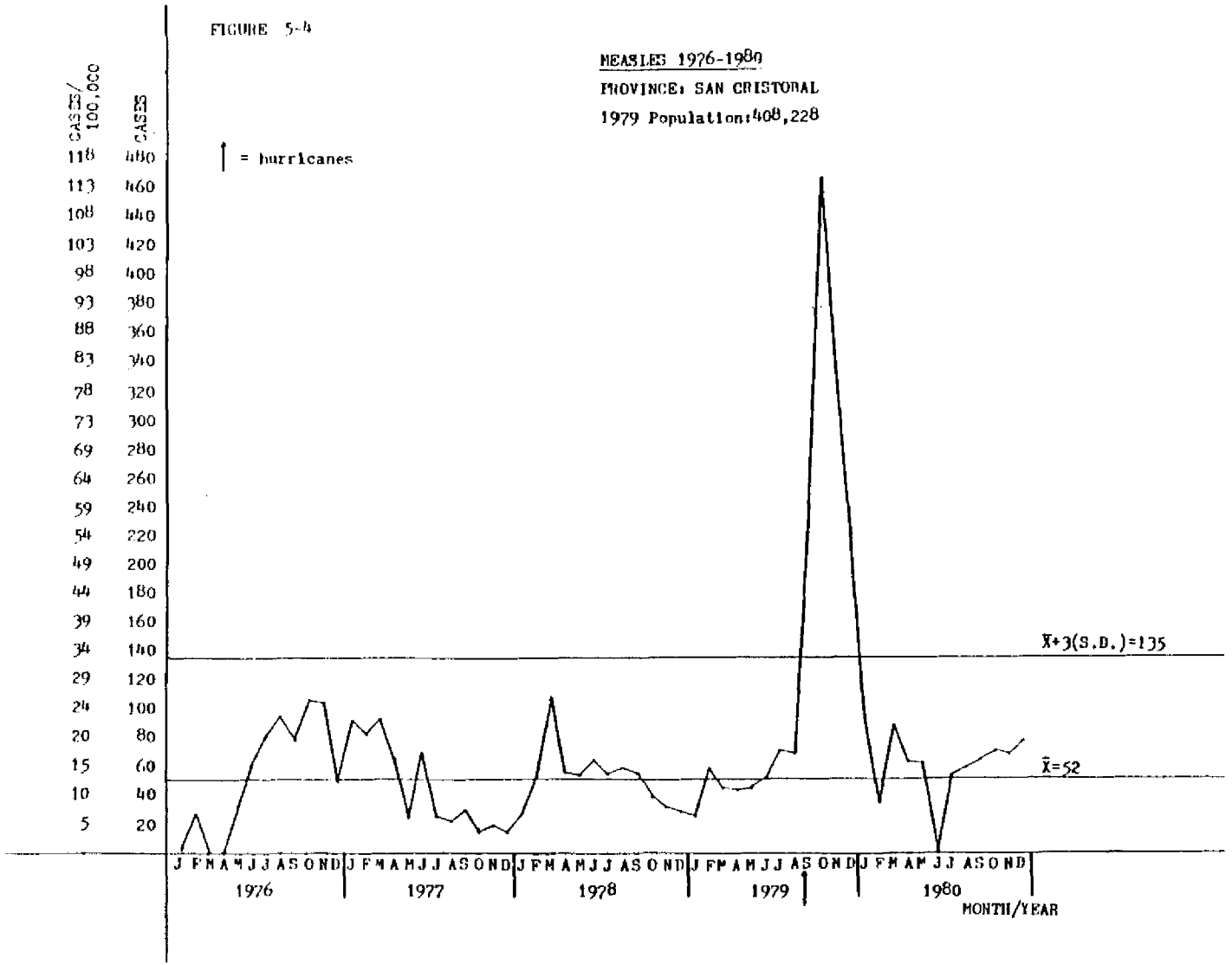

GASTROENTERITIS 1976-1980
PROVINCE: SAN CRISTOBAL
1979 Population: 408,228
= hurricanes
CASES/100,000
CASES
735 3000
686 2800
637 2600
588 2400
539 2200
490 2000
441 1800
392 1600
343 1400
294 1200
245 1000
196 800
147 600
98 400
49 200
X̄+3(S.D.)=1157
X̄=497
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977
1978
1979
1980
MONTH/YEAR

FIGURE 5-4


MEASLES 1976-1980
PROVINCE: SAN CRISTOBAL
1979 Population: 408,228
↑ = hurricanes
CASES/ 100,000
CASES
118 480
113 460
108 440
103 420
98 400
93 380
88 360
83 340
78 320
73 300
69 280
64 260
59 240
54 220
49 200
44 180
39 160
34 140
29 120
24 100
20 80
15 60
10 40
5 20
X̄+3(S.D.)=135
X̄=52
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977
1978
1979
1980
MONTH/YEAR

are fundamentally different from the findings in most recent disaster epidemiology work. What could have been the causes of these increases, and what do they mean?

Most previous disaster epidemiology work in developing countries has followed seismic disasters. Although earthquakes may cause large numbers of deaths and traumatic injuries, in poor rural areas they rarely seriously disrupt water or food supplies. (This may differ significantly in cities because of their dependence on the conveyance of water and food from the outside by way of fragile transport systems.) Hurricanes, however, may destroy crops and food storage through the effects of high winds and flooding. The flooding also often overruns established methods of separating human waste from potable water, thereby contaminating available water. Another basic difference between earthquakes and hurricanes is the difference in likelihood that disease carriers will infect others. Earthquake victims often flee established structures for the perceived increased safety of living in the open during the period of expected aftershocks. In effect, people disperse, thereby decreasing the probability of communicating disease. Hurricane victims, on the other hand, often crowd together in the few structures thought to be capable of withstanding the wind forces of the storm. The increased crowding, often extreme, increases the probability of disease communication, particularly when sanitary facilities are insufficient.

Much of the previous disaster epidemiologic work has covered a period of time of only several weeks after a disaster. But, epidemics require some time to develop; it usually takes a pathogen several

generations to reach maximum distribution in a given population. For example, a disease like hepatitis, which has a long incubation period, may require four to five months before reaching its maximum distribution in a vulnerable population. For this reason, this portion of the study covers a five-year span, including sixteen months following the hurricanes.

The proposed reason for the increase in typhoid and paratyphoid fevers is the flood-caused water contamination discussed above. The magnitude of the increase also leads one to suspect that there was low population compliance with the government-sponsored campaigns aimed at convincing the populace to boil its water in the post-disaster period. (Direct evidence of poor compliance is demonstrated in Chapter 7 of this work.) Furthermore, most of the typhoid vaccination accomplished following the hurricanes was done relatively close to the national capital, Santo Domingo, not in distant Estrelleta, on the border with Haiti.

The suspected primary mode of hepatitis transmission was the extreme crowding which took place as people took shelter from the storms. The more solid buildings, in which people sought refuge for up to forty-eight hours at a time during the storms, were often quite small, providing standing room only in many cases for the duration of the cyclones. There were often no sanitary facilities, and people simply had to relieve themselves wherever they were. (In the research community, Juan Barón, 5,000 people crowded into three small concrete buildings while every other structure in the community disintegrated in the winds. Because there were two hurricanes, this situation lasted

over a week, with the crowd dissipating only slowly thereafter.) With such high crowding and poor sanitary facilities, it is clear that certain populations were exposed to a much higher than normal concentration of urine and fecal matter. The observed delayed peak period of hepatitis is most likely due to the relatively long incubation period of the disease.

In the instance of gastroenteritis, the magnitude of the increases fell off in direct proportion to the provinces' increasing distance from the centers of the hurricanes and their incumbent wind damage. The apparent correlation between exposure to wind damage and increased incidence of gastroenteritis may be due to the indirect causal relationship discussed above under hepatitis. That is, high winds forced people to flee for safety to the few available solid structures, where high crowding resulted in increased exposure to human wastes. It is also possible that the flooding could have been responsible for considerable increased transmission of the pathogens. However, it is remarkable that although all provinces experienced heavy flooding, the provinces exposed to more severe wind damage also demonstrated a higher magnitude of gastroenteritis.

Measles also showed a relationship to the damage caused by the storms. It is clear that the airborne droplet transmission of measles would be increased under the conditions of sudden extreme population crowding. Furthermore, the disease is highly endemic in the Dominican Republic, with a 1978 rate of 113.1 cases per 100,000 population.[6] Vaccination programs have proven ineffective in stemming a generalized

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[6] Op cit, PAHO: p. 332.

natural increase in the disease, the suspicion being that this may be partly due to poor cold-chain maintenance during distribution and administration of the vaccine.[7] The dramatic increase experienced in some provinces after the hurricanes provides evidence that an insufficient portion of the vulnerable population had been provided immunity by the previous years' vaccination campaigns.

It appears that there are two reasons that the above disease increases occurred in the Dominican Republic, but were not reported following hurricanes in the Philippines and Bangladesh, which were discussed in Chapter 2. From what I can find in the available literature, neither study population in the Philippines or Bangladesh experienced the crowding found in the Dominican Republic. The Philippine population was in Manila, the capital city, where safe refuge was more abundant and evenly dispersed than is the case in the rural Dominican environment. In Bangladesh, there was little warning of the flood surge, which killed hundreds of thousands quickly, and left the survivors dispersed.

The second difference is in the manner that the flooding would have affected biological contamination of potable water supplies. Rural Dominicans typically concentrate their human wastes away from potable water by using latrines or pits for that purpose. The flood waters from the hurricanes overran the latrines and wells alike, thereby contaminating normally "safe" water sources. In Bangladesh, human refuse is more generally dispersed and often used as nightsoil, and

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[7] Personal communication from Dr. Amiro Pérez Mera, Oficina Nacional de Estadística, Santo Domingo.

creates a continuous threat to public health. It is thought that the storm surge, which came quickly and then washed back out to sea, probably had the effect of diluting the concentration of contaminants, by carrying them out to the sea. Sommer and Mosley also suggested that the storm surge effectively killed all of the weaker members of the disaster-affected population, particularly the very young and those adults who were older or perhaps weakened by disease or malnutrition.[8] The resultant "survival of the fittest" may have selected out the population most likely to have experienced post-disaster disease increases. No similarly selective mass mortality occurred in the Dominican Republic. The authors of the report on the Philippine typhoons were not sure why water contamination-related diseases did not significantly increase, as they were expected to.[9]

Conclusions

Four of the five diseases studied here showed significant increases in incidence during the post-disaster period. Various disaster-caused changes in the environment were posited as causal factors in the observed increases, and the statistical analysis assures us, with better than 99.9 percent surety, that the increased incidence rates were not the result of random fluctuations. The magnitude of some of the increases, up to a twenty-eight fold increase, surely

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[8] Sommer, Alfred, and Wiley H. Mosley: "East Bengal Cyclone of November 1970," LANCET I, 13 May, 1972, pp. 1029-1036.

[9] Velimirovic, B. and M. Subramanian: "The Pattern of Morbidity After Typhoons in a Tropical Country," International Journal of Biometeorology, vol. 16, No. 4, 1972, pp. 343-360.

qualifies the cases under the definition of epidemic. All of the diseases studied are potentially dangerous for certain age groups, and, at the very least, attack human energy sources at a time when they are most needed for the energy-absorbing tasks of recovery and reconstruction following disaster.

It is clear that the peaks in the incidence occurred several months after the initial impact of the disaster agent, as well as several weeks to several months after disaster relief teams had left. I suggest that this delayed disease impact may be partially responsible for the fact that other disaster epidemiology groups have rarely been able to document post-disaster disease increases. They either left too early, or were monitoring disasters, such as earthquakes, which produce a high degree of trauma but little interruption of sanitary systems, particularly in low-technology rural areas. On the other hand, the specific spacing of the delayed impacts strengthens the argument that the observed increases were indeed related to the hurricanes, due to the way that the delays accurately reflect the known pathogenesis of the diseases.

Community Level

This second portion of the presentation of the epidemiologic findings is based on two surveys. Because of significant differences in both the approach and content of the two-week and two-year surveys, the survey results will be presented separately. Each survey is divided into a section on diseases and a section on injuries. We will conclude with a discussion of the combined results of both surveys and their

meanings. The discussion of the results of the population surveys is followed by a presentation of the health impact reports taken from health promoters and community leaders.

The Two-Week Survey: Disease

The first survey asked the "head of household" to report for the entire family. The number of household inhabitants is not well enough known to make use of direct numerator/denominator analysis. The percentages listed in Table 5-2 are therefore the percentage of families who answered positively to a particular symptom. It is unknown how many people in the respondent's family exhibited the symptom. Symptoms were used in the survey rather than disease categories, because these survey data were obtained from a low-literacy, medically untrained population.

One can only hope to obtain general impressions from the data in Table 5-2. Because this survey took place only two weeks after Hurricane Frederick, it is obvious that many diseases would not have had time to fully develop. However, it should also be noted that most disaster health teams would probably not stay on site longer than this short time period.

Overall, 89.5 percent of the families reported a disease episode. Unfortunately, we do not know how many people were affected by each disease reported. The most commonly reported disease complaints were colds and undefined fevers. Because this population is familiar with dengue and malarial fevers and did not report them, the undefined fevers were probably of viral or bacterial origin. As would be expected, diarrhea and diarrhea with vomiting were relatively common.

Table 5-2
Symptoms and Disease Complaints: Two Weeks After the Hurricanes

Disease or Symptom	Communities: Juan Baron 60 Families #	%	Palenque 70 Families #	%	Yaguate 90 Families #	%	Totals 220 Families #	%
Cold or Influenza	12	20.0	12	17.1	30	33.3	54	24.5
Undefined fever	18	30.0	12	17.1	18	20.0	48	21.8
Vomiting plus diarrhea	6	10.0	4	5.7	8	8.9	18	8.2
Diarrhea only	5	8.3	8	11.4	4	4.4	17	7.7
Measles	5	8.3	10	14.3	0		15	6.8
Nervousness	0		1	1.4	8	8.9	9	4.1
Vomiting only	3	5.0	3	4.3	1	1.1	7	3.2
High Blood Pressure	2	3.3	2	2.9	3	3.3	7	3.2
Stomach-ache	2	3.3	2	2.9	2	2.2	6	2.7
Sore throat	0		0		3	3.3	3	1.4
Headache	0		0		3	3.3	3	1.4
Body pain	0		1	1.4	1	1.1	2	0.9
Dysentary	1	1.7	0		0		1	0.5
Cholera	1	1.7	1		0		1	0.5
Heart attack	1	1.7	0		0		1	0.5
Congested Chest	0		0		1	1.1	1	0.5
Reumatism	0		0		1	1.1	1	0.5
Itches	0		0		1	1.1	1	0.5
Hepatitis	0		0		1	1.1	1	0.5
Anemia	0		1	1.4	0		1	0.5
#Complaints/ #Families	56/60	93.3	57/70	81.4	84/90	93.9	197/220	89.5

Measles was reported surprisingly frequently, which corresponds with the measles increase noted in the provincial data.

Injuries: Two-Week Survey

The two-week survey asked only whether someone in the family had been injured during the hurricanes. It did not ask the type of injuries or other related questions. The results appear below in Table 5-3.

Table 5-3

Did You or Someone in Your Family Suffer Injury During the Hurricanes? (9/79)

RESPONSE	COMMUNITIES							
	JUAN BARON 60 Families		PALENQUE 70 Families		YAGUATE 90 Families		TOTALS 220 Families	
	#	%	#	%	#	%	#	%
Yes, myself	10	16.7	3	4.3	11	12.2	24	10.9
Yes, self and spouse	2	3.3	3	4.3	1	1.1	6	2.7
Yes, several children	4	6.7	3	4.3	4	4.4	11	5.0
Yes, spouse, self & children	0		0		0		0	
Yes, spouse & children	0		0		0		0	
No, no one	42	70.0	60	85.7	74	82.2	176	80.0
No answer	0		1	1.4	0		1	0.5
Total yes	16	26.6	9	12.9	16	17.7	41	18.6

Between twelve percent and twenty-eight percent of the familiies reported injuries to one or several family members. While these data do not tell us what percentage of family members were injured, it is surprising to find an average of eighteen percent of the families reporting some trauma. Other hurricane studies have generally indicated that people were either killed or escaped injury altogether. It is also surprising that Yaguate, which has a greater complement of hurricane-resistant concrete buildings, apparently suffered more traumatic injury than did Palenque. It is possible that Yaguate residents, with a false sense of security provided by their structurally stronger community, failed to seek shelter until the storm was already

upon the town.

The Two-Year Survey: Diseases and Symptoms

Doing a survey two years after the event presents both advantages and disadvantages to the researcher of disaster epidemiology. The greatest advantage is that it allows the researcher an opportunity to examine health conditions that followed the disaster, but which appeared more than a few weeks after the event. The major disadvantage, of course, is that people's memories become less accurate over time. They often forget all but the most important events. It is possible that after the passing of two years, the survey respondents' recall of specific post-disaster health problems suffer from diminished clarity. On the other hand, a major natural disaster is a highly important and memorable event in people's lives, and would thus be less easily forgotten. Perhaps it would make more sense to do future studies of this kind one year after the disaster, but this proved impossible for this researcher.

This second survey asked respondents to report on the specific symptoms or diseases they suffered in the postdisaster period (Table 5-4). About ninety-five percent of the diseases reported here occurred within two months or the hurricanes. The dominant symptoms reported are not unlike those in the first survey: diarrhea, fever with body pain, headache, unspecified rever, vomiting, and coughing. Since we are observing symptoms here, we should note that each symptom may represent several possible diseases. For example, diarrhea was extremely widespread. It may represent gastroenteritis of various types,

Table 5-4
Two Year Survey: Diseases of Symptoms Experienced in Post-Disaster Period (Number/Percentage/Rate per 100,000)

Diseases or Symptoms	Communities: Juan Baron 204 Resp.	Palenque 291 Resp.	Yaguate 220 Resp.	Totals 715 Resp.
Diarrhea	14/6.9/6863	35/12.0/12027	7/3.2/3182	56/7.8/7832
Unspecified fever	11/5.4/5392	24/8.2 / 8247	6/2.7/2727	41/5.7/5734
Cough	7/3.4/3431	14/4.8 / 4811	3/1.4/1364	24/3.4/3356
"Tight" chest	6/2.9/2941	13/4.5 / 4467	0/ 0 / 0	19/2.7/2657
Wound infection	0/ 0 / 0	1/0.3 / 344	0/ 0 / 0	1/0.1/ 139
Head congestion	2/1.0/ 980	7/2.4 / 2405	1/0.5/ 455	10/1.4/1398
Vomiting	6/2.9/2941	21/7.2 / 7216	3/1.4/1364	30/4.3/4335
Headache	5/2.5/2451	29/10.0/ 9966	9/4.1/4091	43/6.0/6013
Fever with body pain	9/4.4/4412	31/10.7/10652	9/4.1/4091	49/6.9/6853
Dementia	1/0.5/ 490	0/ 0 / 0	0/ 0 / 0	1/0.1/ 139
Gastroenteritis	0/ 0 / 0	1/0.3 / 344	0/ 0 / 0	1/0.1/ 139
Measles	3/1.5/1470	13/4.5 / 4467	0/ 0 / 0	16/2.2/2237
Colds	1/0.5/ 490	2/0.7 / 687	2/0.9/ 687	5/0.7/ 699
Throat infection	0/ 0 / 0	2/0.7 / 687	5/2.3/2273	7/1.0/ 979
Ear infection	0/ 0 / 0	1/0.3 / 344	2/0.9/ 909	3/0.4/ 419
Malaria	1/0.5/ 490	0/ 0 / 0	1/0.5/ 455	2/0.3/ 279
Parasites	1/0.5/ 490	2/0.7 / 687	1/0.5/ 455	4/0.6/ 559
Skin disease	1/0.5/ 490	0/ 0 / 0	1/0.5/ 455	2/0.3/ 279
Elevated blood pressure	1/0.5/ 490	3/1.0 / 1031	3/1.4/1364	7/1.0/ 979
Nervousness	1/0.5/ 490	5/1.7 / 1718	1/0.5/ 455	7/1.0/ 979
Stomach disease	1/0.5/ 490	4/1.4 / 1375	0/ 0 / 0	5/0.7/ 699
Others	5/2.5/2451	7/2.4 / 2405	5/2.3/2273	17/2.4/2378
Total complaints	76/37.3/37254	218/74.9/74914	60/27.3/27272	354/49.5/49510

influenza, malnutrition, nervous response to grief, or some combination thereof. The widespread fever with body pain could also be influenza, possibly typhoid-paratyphoid fever -- perhaps even dengue or malaria. The headache most probably has much to do with psychological reaction to the tremendous damage done, losses sustained, and the pressure of suddenly living in very crowded, precarious conditions. The coughing is most

likely related to chronic bronchitis and other upper-respiratory tract infections that are endemic in the Dominican Republic and which would opportunistically rapidly transmit in extreme crowding.

What is impressive is not so much what was experienced by the communities surveyed, but rather the degree of it. For the reader who is unfamiliar with epidemiologic work, it may seem unimpressive that 7.8% of the population had diarrhea, representing 7,832 cases per 100,000 population. However, most epidemiologic work reveals less than 100 cases per 100,000 inhabitants, or less than one-tenth of one percent. Measles is highly endemic in the Dominican Republic, at 113 cases per 100,000 per year. Yet, in Juan Barón, this easily identifiable disease had 1,470 cases per 100,000, and in Palenque, 4,467 cases per 100,000 were reported in a two-month period of time. These figures would have to be multiplied by a factor of six in order to be annualized and compared to what is the "normal" background incidence rate, or 8,820 and 26,802 cases respectively.

Because the actual numbers we are dealing with are relatively small, it is best to be cautious with an interpretation of the per 100,000 population rates. What is important, however, is to recognize that very large amounts of some diseases occurred in the post-disaster period. With the exception of influenza, these diseases are largely amenable to medical and public health management. Because these diseases came at a time when the population's energy was needed for the reconstruction or the physical and social systems around it, the afflictions were even more costly than usual to their victims.

Injuries

It was easier to be more specific about injuries. The community respondents were asked about any injuries they received during the hurricanes, the site of the injury, and its cause. The results are presented in Table 5-5. According to the survey, approximately 10% of the population suffered some kind of injury, with considerable variation between communities. The major injury sites were the feet, legs, and nose. Most of the injuries were apparently caused by contact with sharp objects which were either flying or were displaced by the storms. While these types of injuries were, for the most part, not emergent (immediately life-threatening), they carried considerable opportunity for infection if not properly treated.

To some extent, these data correspond with other disaster epidemiologic work, which has found that injury rates in hurricanes are relatively low when compared to earthquakes, tornadoes and flash floods. Nonetheless, a 10% injury rate is still quite high, meaning around 500 injuries to be dealt with by Palenque's 5,000 inhabitants. As compared to earthquakes, however, the types of injuries demonstrated here are of considerably lower gravity.

Only five people died during the hurricanes in the three study communities, one of whom was a malnourished baby whose death was probably not related to the storms. The others were reported to be middle-aged males, all of whom tried to weather Hurricane David outside of established shelters. They were reportedly all fatally injured by flying and falling debris. These five deaths amount to less than one

Table 5-5
Two-Year Survey: Injuries Received with Site and Cause
Number and Percentage of Respondents with Injuries

	Communites											
	Juan Baron 199 Resp.			Palenque 291 Resp.			Yaguate 219 Resp.			Totals 715 Resp.		
Injury Site	#	%	Cause	#	%	Cause	#	%	Cause	#	%	Cause
Eyes	0	0		4	1.3	1a 1b 2c	0	0		4	0.6	1a 1b 2c
Mouth	0	0		0	0		0	0		0	0	
Forehead	2	1.0	1d 1e	1	0.3	1e	3	1.4	3c	6	0.9	2e 3c 1d
Nose	8	4.0	1c 7d	0	0		1	0.5	1d	9	1.3	1c 8d
Ears	0	0		0	0		0	0		0	0	
Head	0	0		0	0		0	0		0	0	
Abdomen	0	0		0	0		0	0		0	0	
Back	2	1.0	2c	0	0		0	0		2	0.3	2c
Chest	1	0.5	1e	0	0		0	0		1	0.1	1e
Shoulders	2	1.0	1f 1e	1	0.3	1c	0	0		3	0.4	1c 1e 1f
Neck	0	0		1	0.3	1e	0	0		1	0.1	1e
Ribs	0	0		0	0		0	0		0	0	
Trunk	0	0		0	0		0	0		0	0	
Hands	0	0		2	0.7	2e	0	0		2	0.3	2e
Arms	1	0.5	1d	2	0.7	1c 1e	0	0		3	0.4	1c 1d 1e
Legs	5	2.5	2c 1e 1f	6	2.0	5e 1g	1	0.5	1e	12	1.7	2c 6e 1f 1g
Feet	13	6.5	1c 1e 10f 1g	7	2.4	1e 6f	9	4.1	1c 4e 4f	29	4.1	2c 6e 20f 1g
All sites	34	17.1		24	8.2		14	6.4		72	10.2	

Cause totals: a=1; b=1; c=14; d=10; e=20; f=22; g=2

Cause codes: a = dust, grit; b = infection; c = blunt trauma;
d = hit or cut by flying corregated roofing;
e = non-specific slash, cut, puncture; f = puncture by nail;
g = other

three-hundredths of a percent of the total three-community population of about 17,000. This means that the study communities, if they suffered a 10% injury rate, experienced more than 300 injuries for each death. This statistic, however, was radically different in some of the nearby non-study communties. In Villa Ocoa, for example, the community's main shelter was washed away by a flash flood, killing a large percentage of the town's population.

Disease and Injury Reporting: Community Leaders

"Community leaders" were selected for interviewing as previously described. One of the questions asked of them was: What were the gravest post-disaster health problems? The responses were open-ended, and are presented in Table 5-6.

Eight of the nine respondents who listed injuries as a major problem specified that these were injuries caused by matallic objects. Among the eighteen respondents, the most universally recognized problem was gastro-intestinal diseases, followed by measles, injuries, and malaria. None of these community leaders were medically trained or directly involved in the post-disaster health care. Their perceptions were based on communications with community members and health care practitioners. The community leaders seem to have forgotten about the high percentage of undefined fever complaints received from respondents in both community surveys. The group quite possibly forgot the undefined fevers because such diseases are so common in this part of the world. The community leaders were, however, aware of other common problems which were exacerbated by the hurricanes: gastroenteritis and

Table 5-6
Community Leaders' Perceptions of Health Problems: What Were the Gravest Post-Disaster Health Problems?
Number of Affirmative Responses

Problem	Community			
	Juan Baron 6 Resp.	Palenque 8 Resp.	Yaguate 4 Resp.	Totals 18 Resp.
Gastro-intestinal disease	4*	3	3*	10*
Measles	3*	6*	0	9*
Injuries	2	6*	1	9*
Malaria	3*	4*	0	7
Colds and influenza	4*	0	1	5
Trash, filth	0	2	1	3
Lack of water	0	2	0	2
Hunger	2	0	0	2
Dengue	0	1	0	1
Lack of sanitary facilities	1	0	0	1
Live birth	0	0	1	1
Lack of medical care	0	0	1	1
High blood pressure	0	1	0	1

* = Problem recognized by at least half of the respondents.

measles. The group's somewhat exaggerated response to malaria is probably due to the importance of this disease in a tropical country and the amount of community attention it receives. Malaria has, indeed, been increasing in the Dominican Republic. It is interesting to note

that there was little connection made between the lack of sanitary facilities and the importance of gastro-intestinal diseases.

Diseases and Injury Reporting: Health Promoters

Health promoters are community members, usually literate women, who have the responsibility of watching over the health conditions of a certain number of families in their area. This USAID-funded program was started in the late seventies, patterned somewhat after China's "barefoot doctors" or the "promotores de salud" trained at the Behrhorst Clinic in Guatemala. The Dominican health promoters monitor family health conditions and keep written records of them. They are also taught to administer injections and certain common oral medications, to recognize and treat some common diseases, and function as community educators in nutrition and birth control.

All three of the study communities have health promoters. However, only in Juan Barón were they certified and working at the time of the hurricanes. For the other two communities, they were still in training, but had already become involved in the health conditions of their communities. As interested and trained observers, their responses to the interview questions should be considered useful.

The health promoters were interviewed at the two-year anniversary of the hurricanes. They were specifically asked about the types of diseases and injuries they saw during and immediately after the hurricane period. The questionnaire asked the health promoters to mark the injuries and diseases which were most common in their communities. They did this without discussing the answers with each other, yet within

each community, the level of agreement is quite high. The numbers given in Tables 5-7 and 5-8 (A-C) represent the number of affirmative responses given for each injury or disease type.

Table 5-7
Injury Reporting by Health Promoters

	Communities			
Injuries	Juan Baron 8 Resp.	Palenque 6 Resp.	Yaguate 7 Resp.	Totals 21 Resp.
Corregated roofing injuries to:				
Head	7*	4*	3	14*
Hands	2	1	2	5
Arms	8*	0	4*	12*
Trunk	0	0	1	1
Legs	7*	1	3	11*
Feet	3	3*	3	9
Nail injuries to:				
Head	0	1	1	2
Hands	0	0	1	1
Arms	0	0	0	0
Trunk	0	0	1	1
Legs	0	0	2	2
Feet	5*	3*	5*	13*
Injury by other flying debris:				
Head	7*	0	2	9
Hands	1	3*	1	5
Arms	0	2	1	3
Trunk	0	0	0	0
Legs	0	4	2	6
Feet	0	1	0	1
Foreign object in the eyes:	8*	3*	6*	17*

* = Condition recognized by at least half of the respondents.

Table 5-8 A
Disease Reporting by Health Promoters
Number of Positive Responses

JUAN BARON (8 Respondents)	PREDOMINANT AGES								
Disease	0-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61--
Cold	7*	7*	3	0	0	0	0	0	0
Influenza	8*	8*	5*	1	1	1	0	0	0
Vomiting w/ diarrhea	7*	5*	1	1	0	1	0	0	0
Vomiting w/o diarrhea	8*	1	0	0	1	1	0	0	0
Diarrhea only	7*	2	3	7*	7*	0	0	0	0
Undefined fever	2	0	0	0	2	1	0	0	0
Typhoid fever	2	0	0	1	1	2	0	0	0
Hepatitis	0	0	0	0	0	0	0	0	0
Malaria	0	0	1	8*	0	0	0	0	0
Measles	7*	3	0	1	0	0	0	0	0
Eye infection	8*	4*	6*	7*	2	1	0	0	0
Skin infection	8*	8*	8*	1	1	1	0	0	0
Ear infection	8*	7*	1	2	0	0	0	0	0

* = Condition recognized by at least half of the respondents.

The injury reporting corroborates information provided by community members. It is interesting to note the high degree of agreement among health promoters on the problem of the intromission of foreign objects into the eyes. There are several other interesting aspects about the information provided by the health promoters. First, it provides an opportunity, however imperfect, to examine the age distribution of the diseases experienced post-disaster. Both the data from the Ministry of Public Health and from the two-year survey were unfortunately unable to provide this information. While colds and influenza had a relatively even age distribution, measles and ear infections were predominant in the lower age groups, as would be expected. In the gastro-intestinal diseases, vomiting with and without

Table 5-8 B
Disease Reporting by Health Promoters
Number of Positive Responses

PALENQUE (6 Respondents)	PREDOMINANT AGES								
Disease	0-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61--
Cold	6*	6*	6*	6*	6*	6*	6*	6*	5*
Influenza	1	1	0	0	0	0	0	0	0
Vomiting w/ diarrhea	6*	1	0	0	0	0	0	0	0
Vomiting w/o diarrhea	0	0	0	0	0	0	0	0	0
Diarrhea only	6*	6*	6*	6*	6*	6*	6*	6*	4*
Undefined fever	1	1	1	1	1	1	1	1	1
Typhoid fever	0	0	0	0	0	0	0	0	0
Hepatitis	0	0	0	0	0	0	0	0	0
Malaria	0	0	0	6*	6*	6*	6*	6*	5*
Measles	6*	6*	6*	6*	2	0	0	0	0
Eye infection	6*	6*	6*	6*	6*	6*	6*	6*	2
Skin infection	6*	6*	6*	6*	6*	6*	6*	6*	3*
Ear infection	3*	0	0	0	0	0	0	0	0

* = Condition recognized by at least half of the respondents.

diarrhea was concentrated in children under ten years of age. "Diarrhea only" was more evenly distributed among all ages. This poses the question of whether different age groups were exposed to or susceptible to different pathogens, or whether they simply responded differently to the same pathogens. I suspect that the younger children, particularly in the refugee shelters, were more directly exposed to fecal matter than were the adults, who would presumably be a little more careful in their habits. This is important where there is a dose-response curve to the pathogen, as often seems to be the case with gastro-intestinal diseases. It may also be that children react more violently to gastro-intestinal pathogens, due to their relatively lesser developed immune response

Table 5-8 C
Disease Reporting by Health Promoters
Number of Positive Responses

YAGUATE (6 Respondents) PREDOMINANT AGES

Disease	0-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61--
Cold	5*	5*	5*	5*	5*	5*	5*	5*	5*
Influenza	6*	1	1	1	4*	6*	5*	5*	5*
Vomiting w/ diarrhea	6*	1	0	0	0	0	0	0	0
Vomiting w/o diarrhea	6*	1	0	1	1	1	1	1	1
Diarrhea only	4*	1	0	2	2	4*	4*	4*	4*
Undefined fever	0	0	1	1	1	1	1	1	1
Typhoid fever	0	0	0	0	0	0	0	0	0
Hepatitis	0	0	1	3*	3*	3*	3*	3*	3*
Malaria	6*	6*	6*	5*	5*	4*	4*	4*	4*
Measles	1	1	0	0	0	0	0	0	0
Eye infection	1	0	0	6*	2	2	2	2	1
Skin infection	3*	5*	5*	6*	6*	5*	5*	5*	5*
Ear infection	6*	4*	2	0	0	0	0	0	0

* = Condition recognized by at least half of the respondents.

systems. It is likely that the vomiting and diarrhea episodes reported were caused by a variety of pathogens which could not be clinically differentiated, and certainly not by the health promoters.

Also of interest was the relative predominance of eye and skin infections. These diseases had a fairly even age distribution in Palenque and Yaguate, and were concentrated in the younger ages in Juan Barón. In at least one case outside of the study communties, an outbreak of "skin infections" was confirmed to be scabies.[10] Whether scabies, tinea, impetigo, or some other infectious agent, the extreme crowding in the shelters was the probable cause of the high infection

[10] Personal communication from Dr. Oscar Rivera Rivera, Chief of Health Unit, Agency for International Development, Santo Domingo.

rate. The reported relatively short duration of the skin infections suggests that they were not of tuberculin, syphilitic, or malnutrition origins. There was no laboratory confirmation of the pathogen in the eye infections. Most conjunctivitis agents are highly contagious, and were probably also transmitted during the periods of crowded sheltering. Some of the conjuntivitis may also have been caused by the wind-blown intromission of foreign matter into the eyes during the storms.

Additionally, 20 of the 21 interviewed health promoters (one failed to respond) said that the number of live births had increased nine months after the hurricanes. The reasons suggested by the promoters were the following: 1) the lack of electric lights (and television) for months following the hurricanes, and 2) a high level of sexual activity in the refugee centers following the hurricanes.[11] Many health promoters also gave oral reports of an increase in venereal diseases following the hurricanes, but had no hard data to offer. These data were also not available from the Ministry of Public Health at the time of this research, but this problem would be examined in future studies of disaster epidemiology.

Overall Health Analysis: Community Level

The two-week survey, the two-year survey, the community leaders, and health promoters all gave similar disease reports: colds and influenza, undefined fevers, variable gastro-intestinal diseases, measles, and malaria. The two-year survey added headache and coughing, and the health promoters were nearly unaminous in emphasizing skin and

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[11] In the Dominican Republic, it is not unusual for sexual activity to take place without the benefit of much privacy.

eye infections. All of these diseases are potentailly sensitive to flooding and shelter crowding, as discussed above in regard to the provincial data. These findings corroborate the provincial level findings in terms of measles and gastro-intestinal diseases. The low mention of typhoid fever and hepatitis was expected at the community level, as these are diseases which do not affect large percentages of people, even in the proportions seen in San Cristóbal after the hurricanes. Hepatitis was reported by health promoters in Yaguate, and typhoid fever was mentioned in Juan Barón. There is little chance that cases of hepatitis went unnoticed, at least in adults, due to its peculiar symptoms. Typhoid fever, however, may have been underreported, passing as severe cases of gastroenteritis, "undefined fever," or particularly, "fever with body pain."

The analysis of malaria is somewhat more difficult to make. We do not have the ability to compare pre- and post-disaster malaria incidence at the community level. All communities reported an increase in malaria following the hurricanes, but all community members I spoke with were unaware that the entire nation had been experiencing a rapid increase in malaria incidence in the previous few years. Only in Yaguate did the health promoters report that there had been an "outbreak" of malaria, but reported that it was short-lived.

The reports of increased post-disaster incidence of skin and eye infections represent diseases not previously examined in the disaster context. Scabies are not unusual in the Dominican Republic, and the island's residents suffer frequent epidemics of conjunctivitis, the most recent being in 1981. The skin infections, scabies or other possible

types, are medically treatable and are not life-threatening. Conjunctivitis is also treatable if it is of the bacterial variety. In any case, although temporarily debilitating, it is self-limiting and does not pose a medical emergency.

In regard to injuries, the information presented by the different community sources is quite specific and corroborative. In the two-week survey, a combined 18.8% of the families interviewed reported that someone in the home had been injured. In the two-year survey, 10.2% of the individuals reported that they had been injured in some way during the hurricanes. The major sites of injury were the feet, legs, nose, forehead, and eyes. The major injury causes were puncture by nails, non-specific punctures or cuts, blunt trauma, and cuts or impact by corregated roofing. There were few reported orthopedic injuries, and there were only five reported deaths in the combined population of about 17,000 inhabitants. One of the five deaths was an infant who died of malnutrition-caused weakening, and probably would have died had there been no hurricane. All others were killed by building collapse outside of the refugee centers. No one was reported to have died of injuries because of inaccessibility to medical care. Injuries caused by the hurricanes appeared to be either quickly fatal or of a non-life-threatening character.

DISEASE AND INJURY REPORTING: RELIEF PROVIDERS

The relief providers who were interviewed represent the Dominican Red Cross Office of Emergency Relief, the Dominican Civil Defense, the Dominican Ministry of Public Health and its Health

Education Program, the U.S. Agency for International Development (both its disaster relief coordinator and its health officer), CARE, CARITAS, Medical Group Missions Program, and the Mennonite Disaster Service. They were asked what they saw to be the principal causes of disaster-related deaths, the principal disease and injury problems following the disaster, and the major post-disaster sanitary problems.

The principal causes of death, according to these relief providers, was first flooding, and then fatal traumatic injury.[12] Most of the flooding deaths were reportedly caused by flash floods which occurred during Hurricane David, with some additional deaths coming during Hurricane Frederick. The principal causes of traumatic injury deaths were reportedly falling structures and flying debris, with flying corregated roofing being mentioned several times.

Only one of the program directors interviewed, John Shannon of the Medical Group Missions Program, personally provided medical relief. The hurricanes trapped him in one of the small coastal communities hit by the eye of the storms, not far from the study communities. He reported 38 dead in the surrounding villages, all from traumatic injury. Few solid shelters were available. In the first few days after Hurricane David, Shannon and a medical student treated more than 200 people with serious lesions, many with material embedded in the skin, and set "a good number of broken limbs." One patient with a broken back was brought to him, strapped to a door. The patient had to be hand carried, on the door, to the nearest hospital in San Cristóbal, some 20 kilometers away. The most common disease problems reported by Shannon

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[12] No official study was done of the causes of hurricane-related deaths. Post-mortems are only infrequently done in the Dominican Republic.

were gastro-intestinal illnesses and infected eyes.

The most common post-disaster health problems reported by the others were gastro-intestinal diseases, colds and influenza, measles, malaria, fevers, and scabies, to which the Red Cross added diphtheria and tuberculosis. Corroborative data on the latter two diseases could not be obtained. The health ministry official who was interviewed reported a serious outbreak of "depression" in Villa Ocoa, where a large percentage of the town's people had been killed. The official from the health education program also reported an increase in sexually transmitted diseases, and stated that there had been numerous problems with sexual relations, even rapes, in some of the refugee centers.

Regarding sanitary problems, all agreed that the most important problem was water contamination. The other major problems listed were overcrowding and a lack of sanitary facilities in the refugee shelters, lack of general cleanliness, and contaminated food preparation.

OVERALL HEALTH ANALYSIS: WHAT WERE THE HEALTH PROBLEMS, AND WHAT WERE THE NEEDS?

The following health findings emerge from the various data sources examined. 1) Injuries affected about ten percent of the population. The most common wounds were puncture wounds or lacerations to the feet, legs, and face, often with some debris being embedded in the skin. Many people also complained of foreign objects in the eyes, which was followed by a reportedly high rate of eye infections. There was a relatively low rate of orthopedic injuries, but they, nonetheless, existed.

The community data used here are not perfect. The numbers

examined are too small to generalize widely, but they do provide a good indication of what injuries are possible among hurricane-affected populations. More study is needed to determine what proportion of a community, such as those studied in this research, is likely to be injured in hurricane disasters. Much of the "third world" lives in communities similar to these.

2) The most common and problematic post-disaster diseases were colds and influenza, undefined fevers, gastro-intestinal diseases, measles, typhoid and paratyphoid fevers, hepatitis, skin infections, and eye infections. Venereal diseases were mentioned by several sources, but insufficient data existed for a reasonable investigation of the problem. In the first community survey between 26.8% and 44.8% of the population reported they became ill in the first two weeks. In the two-year survey, an average of 26.4% of the respondents reported having been ill in the post-disaster period, with 95% of the diseases reported to have occurred within the first two post-disaster months. The delayed-impact diseases discussed at the provincial level -- measles, typhoid-paratyphoid fevers and hepatitis -- clearly affected a smaller proportion of the population than did colds, influenza, "fevers," and gastro-intestinal diseases, but the post-disaster rates of these diseases were extraordinarily high.

What were the needs created by the above health problems? The injuries created a need for bandaging, wound cleaning supplies and services, antiseptic ointments, eyebaths, and opthamologic ointments, and some casting material and x-ray capability. The diseases increased the need for safe water, rehydration mixtures, fever and pain control

drugs such as aspirin, properly applied measles vaccine, specialized and broad-spectrum antibiotics, pediculicides, and close epidemiologic surveillance. Where typhoid rates were seen to climb, a mass vaccination program might possibly have been helpful in decreasing the impact of the disease, although this has not been clearly demonstrated. Where an increase of hepatitis was found, immunization of the most vulnerable with immune serum globulin may have proven an effective method of control.

It should be remembered that the above needs came at distinctively different time periods. The injury mitigation supplies and medical personnel were needed immediately after the hurricanes, well-distributed to the most severely affected portions of the country. The need for analgesics and rehydration supplies came coterminously with trauma care, or shortly thereafter. The need for epidemiologic surveillance continued for months, as did preventive and curative methods for the control of the delayed-impact diseases. All the while, the population was trying to rebuild, re-establish food production and distribution, and re-start a severely damaged economy.