Am. J. Trop. Med. Hyg., 31(3), 1982, pp. 574–578
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CIGUATERA FISH POISONING: EPIDEMIOLOGY OF THE DISEASE ON ST. THOMAS, U.S. VIRGIN ISLANDS*

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Abstract. In a random household survey conducted on St. Thomas, U.S. Virgin Islands, the incidence of ciguatera fish poisoning was found to be 36.5 cases per 1,000 population per 5 years (95% confidence limits ±16.9 cases per 1,000 population per 5 years). An average of 3.6 cases per 1,000 population per year were diagnosed in the hospital emergency room on St. Thomas. Cases seen in the emergency room occurred most frequently among persons aged 30–39 years. No clear seasonality for cases could be demonstrated. In an investigation of cases occurring between 1 January and 10 April 1980, illness was caused by a variety of different fish, with carrang (*Caranx ruber*) the species most commonly implicated. Patients and age-matched controls ate fish with equal frequency; patients were significantly more likely to have had previous episodes of ciguatera fish poisoning than were controls.

Ciguatera fish poisoning, with its distinctive combination of gastrointestinal and neurologic symptoms,[1,2] has been reported from a broad circumglobal belt extending approximately from latitude 35°N to 34°S.[3] The disease is caused by eating fish containing a toxin thought to be produced by the dinoflagellate *Gambierdiscus toxicus*;[4] toxic fish have normal taste and appearance.[2] Although there are experimental assays for detecting toxic fish,[5,6] the diagnosis in most cases must still be made clinically. Patients typically present with gastrointestinal symptoms (primarily diarrhea) within several hours of eating fish.[7] These symptoms are followed by neurologic manifestations, including paresthesias, reversal of hot and cold sensation, itching, and pain and weakness in the lower extremities;[1,7–9] neurological manifestations may persist for weeks or months.[7]

Despite its widespread occurrence and the distinctive nature of the clinical syndrome, studies of ciguatera fish poisoning are limited; in particular, little is known about the disease's epidemiology, and there are virtually no data on incidence in endemic areas. In an effort to obtain such data we undertook a study of the disease within a defined geographic area, the island of St. Thomas in the U.S. Virgin Islands. Our study included a random household survey, a survey of physicians, a review of hospital emergency room records, and an investigation of recent cases. Our data indicate that ciguatera fish poisoning is an important cause of morbidity on the island, and suggest that identification of specific risk factors for illness may be possible.

MATERIALS AND METHODS

Random household survey

Maps of property boundaries were used to randomly select nine survey sectors on the island of St. Thomas, U.S. Virgin Islands (population approximately 55,000). Six houses were selected from each of the nine sectors, using a systematic, predetermined method; 228 individuals lived in these 54 households. The ethnic makeup of the sample was representative of the Virgin Islands as a whole. The age distribution differed from that of the general population in having a larger number of individuals in the 10- to 19-year age group (28.4% of survey household members versus 18.9% of U.S. Virgin Island population) and a smaller number in the 20- to 29-year age group (9.9% of survey, versus 19.8% of population).

Respondents were asked whether anyone in the household had had "fish poisoning" (a local term for a syndrome regarded as analogous to ciguatera

Accepted 2 December 1981.

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fish poisoning) in the preceding 5 years. For each suspect episode they were asked to specify symptoms. A case of ciguatera fish poisoning was defined as illness that occurred within 48 hours after eating fish and caused both gastrointestinal (vomiting and/or diarrhea) and neurologic symptoms (dysesthesias, changes in taste, pruritus, and/or pain and weakness in the lower extremities). Additional data requested included information on the type and weight (<1 pound, 1–5 pounds, 6–10 pounds, >10 pounds) of fish eaten in the household during the preceding month. Household members were also asked to supply details about the fish they had most recently eaten.

Survey of physicians

Efforts were made to contact all general practitioners, internists, and pediatricians on St. Thomas. Information was obtained from 14 physicians, including seven in full-time private practice.

Hospital record review

Emergency room log books at the Knud Hansen Memorial Hospital on St. Thomas (the only hospital on the island) were reviewed for 1971, 1977, and 1979. Data were recorded for each person given a diagnosis associated with ciguatera, including "fish poisoning," "post-fish poisoning syndrome," and "acute gastroenteritis secondary to fish poisoning." For two randomly selected months in 1977 log entries were also recorded for individuals with all other gastrointestinal complaints, such as "gastroenteritis," "gastritis," "viral gastroenteritis," "intestinal colic," and "intestinal flu." Data on the total fish catch on St. Thomas, and the catch by each of several methods (fish traps, spear fishing, etc.) were obtained from the Department of Conservation and Cultural Affairs, Government of the Virgin Islands.[10]

Investigation of recent cases

Efforts were made to identify recent outbreaks of ciguatera fish poisoning by contacting individuals who had presented at the emergency room of the Knud Hansen Memorial Hospital on St. Thomas between 1 January and 10 April 1980. An outbreak was defined as all cases resulting from eating a portion of a single fish; 29 possible outbreaks were identified. In 27 (94%) of the 29 outbreaks individuals in the outbreak met our case definition for ciguatera fish poisoning. Single age-matched (±5 years) controls for persons involved in ciguatera fish poisoning outbreaks were randomly selected from individuals for whom data had been obtained during the household survey.

RESULTS

Household survey

All adults questioned in the household survey were familiar with the term "fish poisoning." Of 228 individuals living in surveyed households, 192 (88%) had been in the U.S. Virgin Islands 5 years or longer; during the preceding 5 years there were seven episodes of fish poisoning (all of which met our case definition for ciguatera fish poisoning) among these 192 individuals, for an incidence rate of 36.5 cases per 1,000 population per 5 years (95% confidence limits ±16.9 cases per 1,000 population per 5 years). This represents 7.3 cases per 1,000 population per year. Cases identified in the survey were distributed throughout the 5-year period; there appeared to be little difficulty with recall, with many persons anxious to describe episodes of fish poisoning which had occurred decades before. In five of the seven cases identified the ill person had sought medical attention at the emergency room of the Knud Hansen Memorial Hospital; in the other two cases no physician had been consulted.

Persons in 39 (72%) of the 54 households felt that certain types of fish were more likely to be poisonous than others, with carrang (*Caranx ruber*) and barracuda cited as having the greatest likelihood of being toxic. The fish most commonly eaten by members of the 54 households in the month prior to the survey were old wife (*Balistes vetula*), kingfish, and grouper; in only one household did individuals say that they had eaten carrang.

Survey of physicians

All physicians questioned were familiar with the syndrome of "fish poisoning." Physicians in private practice stated that they saw from less than one case a month to one or two cases per month. In acute cases patients were said to be more likely to go directly to the hospital emergency room for therapy than to a private physician.

TABLE 1

Number of emergency room cases of ciguatera fish poisoning and of other gastrointestinal complaints, by age, and age-specific attack rates, St. Thomas, U.S. Virgin Islands

Age (yr)	Fish poisoning		Other gastrointestinal complaints	
	No. of cases*	Rate†	No. of cases‡	Rate†
0–4	8	0.3	54	36.9
5–9	14	0.6	30	22.7
10–19	64	1.7	41	19.7
20–29	158	4.0	42	19.3
30–39	182	6.4	36	22.9
40–49	89	4.7	24	23.0
50–59	41	3.2	5	7.1
60–69	20	3.0	4	10.7
70	8	1.6	3	11.3
Subtotal	584			
Unknown	9			
Total	593	3.0	239	21.7

* Total for 3 years: 1971, 1977, 1979.
† Per 10,000 population per month.
‡ Total for two randomly selected months, 1977.

Barracuda and carrang were cited as the fish implicated most frequently in outbreaks of fish poisoning.

Hospital record review

During 1971, 1977, and 1979 fish poisoning was diagnosed in 593 of approximately 92,000 patients seen in the Knud Hansen Memorial Hospital emergency room. This included 124 (0.44%) of 27,949 patients in 1971, 240 of approximately 30,000 in 1977, and 239 (0.70%) of 33,906 patients in 1979, for an average of approximately 3.6 cases per 1,000 population per year, or 3.0 cases per 10,000 population per month. This compares with a rate of 21.7 cases per 10,000 population per month for all other gastrointestinal complaints.

The mean age of persons with a diagnosis of fish poisoning was 32.9 years (range 0–81 years); age-specific attack rates were highest for the 30–39 age group (Table 1). Rates did not differ significantly between males and females. For patients presenting with other types of gastrointestinal complaints the highest attack rate was in the 0- to 4-year age group; mean age for these patients was 21.5 years, significantly lower than the mean age of persons with fish poisoning ($P < 0.001$, Student's t-test, unpaired, two-tailed).

There was a great deal of monthly variation in the number of cases, with no clear evidence of seasonality when data from all 3 years were combined (Fig. 1). No correlation was found between number of cases and total fish catch on St. Thomas, or catch by any one method (i.e., fish traps, spear fishing, etc.), for two 6-month periods for which both catch data and emergency room data were available. Addresses were available for patients diagnosed as having fish poisoning during 1979. There was no geographic clustering of local cases; nine persons (4%) gave an address outside the U.S. Virgin Islands or at a hotel and were assumed to be tourists visiting the island.

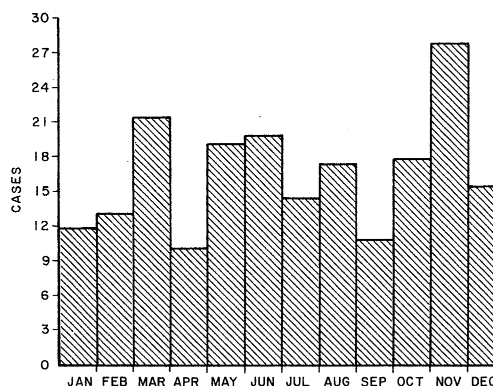

FIGURE 1. Average number of cases of "fish poisoning" diagnosed in the Knud Hansen Memorial Hospital emergency room by month, 1971, 1977, 1979.

Investigation of recent cases

Fifty-three persons were ill in the 27 outbreaks of ciguatera fish poisoning for which data were obtained; this includes 16 "outbreaks" in which only one individual was ill. Seventeen of these 53 persons (including 9 children aged 16 years and under) were not seen in the emergency room or were not listed in the emergency room log book. There were an additional 13 persons in six of the outbreaks who were said to have eaten a portion of the implicated fish but who remained asymptomatic; further data were not available on these individuals.

A variety of fish were implicated in the 27 outbreaks (Table 2), with carrang the most common species. Sixty-three percent of fish implicated in ciguatera fish poisoning outbreaks were in a weight catagory (<1 pound, 1–5 pounds, 6–10 pounds, >10 pounds) above the median weight category

for that species of fish as determined in the household survey, with only 5% below the median weight category. No one source for the fish could be identified, with fish purchased at a number of different locations on the island; in only one outbreak was the fish known to have been frozen rather than fresh. Fish were most frequently prepared by stewing (48% of outbreaks); this is similar to data from the household survey, in which 54% of individuals questioned stated that the last fish they had eaten had been stewed.

Additional epidemiologic data were obtained from 33 symptomatic individuals, including at least one person from each outbreak. Seventy-nine percent stated that they ate fish at least once a week, with one-third eating fish at least three times a week; this did not differ significantly from age-matched controls. In 31% of cases individuals had had at least one episode of ciguatera fish poisoning in the preceding 5 years, compared to 6% of age-matched controls ($P < 0.05$, McNemar matched-pair analysis); this difference was even more significant when patients were compared with all persons in the household survey taken as a group ($P < 0.001$, Fisher's exact test, two-tailed).

TABLE 2

Ciguatera fish poisoning outbreaks, by types of fish involved, U.S. Virgin Islands, 1 January–10 April 1980

Type of fish (local name)	Number of outbreaks (%)
Carrang	4 (15)
Snapper	4 (15)
Grouper	3 (11)
Kingfish	2 (7)
Rock hind	1 (4)
Red hind	1 (4)
Old wife	1 (4)
Porgy	1 (4)
Barracuda	1 (4)
Bonito	1 (4)
Eel	1 (4)
Jack	1 (4)
Sunfish	1 (4)
Redman	1 (4)
Unknown	4
Total	27

DISCUSSION

There are a number of inherent difficulties in this type of retrospective epidemiologic study. In initially identifying cases in our surveys and in our review of emergency room records we made use of the local term "fish poisoning." Persons on the island were uniformly familiar with the term, and almost all cases of "fish poisoning" met our case definition; it is possible, however, that patients with mild or atypical illness may not have been diagnosed, or may have been given alternative diagnoses such as "food poisoning." There are also potential difficulties with our use of a 5-year recall period in the household survey; while recall was clearly facilitated by the distinctive nature of the clinical syndrome, it is possible that milder cases of ciguatera fish poisoning may have been forgotten, resulting in our underestimating the actual incidence of the disease.

In our household survey we identified an average of 7.3 cases of ciguatera fish poisoning per 1,000 population per year; assuming that half to two-thirds of all cases are seen in the hospital emergency room (as suggested by the household survey) this figure is quite close to the 3.6 cases per 1,000 population per year identified in our review of emergency room records. The only other data on incidence of ciguatera fish poisoning in the Virgin Islands come from a random telephone survey conducted in 1978, in which 22 of 100 households contacted reported that the disease had occurred among household members during the preceding 5 years; household size and number of cases per household were not determined, however. In Miami, the incidence of ciguatera fish poisoning has been estimated at 5 cases per 10,000 population per year,[9] or less than one-tenth the rate we found on St. Thomas. No data exist on incidence of the disease outside of the Caribbean area, although there has been a recent report of a large series of cases from the South Pacific.[8]

In looking at risk factors associated with specific outbreaks, we were not able to show that there was an increased risk of toxicity associated with fish purchased during any one season (as had been described in Miami[9]), from any one source, or prepared by any one method. Island residents do seem to feel that certain species of fish, such as carrang, have a higher risk of toxicity. Our data did not show an association between illness and eating carrang; the fish accounted for 15% of our outbreaks, however, while in the household survey it was found that carrang had been eaten in only one (2%) of 54 households in the preceding month. Although the weight categories we selected for fish were arbitrary and rather broad, our study also suggests (in agreement with experimen-

tal work[1]) that larger fish within a single species are more likely to be toxic.

There is an apparent association between illness and age, with the highest attack rate (among emergency room patients) in the 30- to 39-year-old age group; similar age distributions were noted in the South Pacific[8] and Miami.[9] The low attack rate for children may be a reporting artifact (as over half of the ill persons not listed in the emergency room log book were children) or may reflect a difference in susceptibility, with children less likely to become symptomatic after eating toxic fish. There would also appear to be an association between a history of previous episodes of fish poisoning and development of illness. This may reflect behavioral patterns, with individuals who commonly eat potentially toxic fish more likely to be poisoned repeatedly; alternatively, individuals may become sensitized by poisoning, and be more likely to experience symptoms when they eat fish with relatively low levels of toxin.

As demonstrated in this and other studies,[2,8,11] ciguatera fish poisoning is an important cause of morbidity in areas of the tropical world in which there is widespread consumption of tropical reef fish. As toxic fish can be identified only by rather complex laboratory procedures,[5,6] control of ciguatera fish poisoning must ultimately be based on an understanding of the disease's epidemiology, and of risk factors for illness. Our study suggests that identification of risk factors may be possible; further studies are needed to better define these risk factors, and to determine if similar risk factors exist in areas outside of the Virgin Islands.

ACKNOWLEDGMENT

We wish to thank Robert A. Pollard, M.A., for providing statistical assistance in this study.

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