Multiple Outbreaks of Puffer Fish Intoxication in Bangladesh, 2008

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Abstract. During April and June 2008, we investigated three outbreaks of marine puffer fish intoxication in three districts of Bangladesh (Narshingdi, Natore, and Dhaka). We also explored trade of marine puffer fish in Cox's Bazaar, a coastal area of the country. We identified 95 people who had consumed puffer fish; 63 (66%) developed toxicity characterized by tingling sensation in the body, perioral numbness, dizziness, and weakness, 14 of them died. All three outbreaks were caused by consumption of large (0.2–1.5 kg) marine puffer fish, sold in communities where people were unfamiliar with the marine variety of the fish and its toxicity. Coastal fishermen reported that some local businessmen distributed the fresh fish to non-coastal parts of the country, where people were unfamiliar with the larger variety, to make a quick profit. Lack of knowledge about marine puffer toxicity contributed to the outbreaks. Health communication campaigns will enhance people's knowledge and may prevent future outbreaks.

INTRODUCTION

Puffer fish, also globally known as blow fish, balloon fish, toad fish, and globe fish, belong to the order tetrodontiformes.¹ Puffer fish intoxication after consumption of this fish is one of the most common causes of poisoning among people in coastal regions of Asia.¹ Tetrodotoxin, the puffer fish's toxin, is present in the liver, gall bladder, intestine, gonads, eggs, and skin of the fish in sufficient amounts to cause intoxication among people who eat the fish.^{1–4} The body musculature is less poisonous.¹ In humans, this neurotoxin blocks the sodium channel in the excitable cell membrane and causes deadening of the tongue and lips, dizziness, and vomiting followed by numbness and prickling over the body, rapid heart rate, decreased blood pressure, and muscle paralysis.^{1,3,5,6} Death results from respiratory arrest because of paralysis of the respiratory muscles.⁶ Tetrodotoxin poisoning has no specific antidote, but immediate supportive treatment and judicious administration of neostigmine, along with atropine, can minimize fatalities.⁷

Not all species of puffer fish are toxic, and some are only mildly toxic.⁸ The toxicity also varies with sex, season, and geographical variation. The ovaries of the female fish are more toxic than the male testes, and the toxicological pattern varies between temperate and tropical zones.^{6,8–10} In Bangladesh, there are reportedly 13 species of the fish; two live in fresh water, whereas the others are marine puffer fish.⁶ Although there are reports on toxic analyses of two fresh-water and three marine-water species of puffer fish, information about other toxic and non-toxic species of puffer fish in Bangladesh is not available.^{9,11}

There are published reports of sporadic episodes of puffer fish toxicity in Bangladesh, primarily from districts in the coastal region.^{3,12} These reports have focused on the clinical and toxicological analysis of puffer poisoning, with little information on local availability of the fish or the communities' knowledge and understanding of toxicity of the fish.^{1,3,7,12,13}

During April and June 2008, a collaborative team from the Institute of Epidemiology, Disease Control and Research (IEDCR) and International Center for Diarrheal Disease Research, Bangladesh (ICDDR, B) investigated three differ-

ent outbreaks of puffer fish poisoning in Narshingdi, Dhaka, and Natore Districts. Subsequently, the investigation team visited one of the coastal areas of the country to explore the availability and trade of the deep-sea variety of the fish, to understand the extent of the fishermen's knowledge about its toxicity, and to provide health authorities with information necessary to control and prevent future intoxications.

METHODS

Outbreak reporting and case detection. The outbreaks were initially identified by the local health authorities when people began seeking treatment in the three local health facilities of the three districts. We conducted descriptive studies in the outbreak affected areas to define the outbreak in terms of person, place, and time. First, we visited these facilities and collected lists of people who developed symptoms after consumption of the fish and came to these facilities for treatment. We defined a case patient as a person who had consumed puffer fish and developed tingling sensation in the body and/or perioral numbness and/or dizziness within 24 hours of consuming the fish. We also searched for people who consumed puffer fish but did not develop symptoms by asking case patients if they were aware of any other people in their neighborhood/community who had consumed the fish. The team collected information from people who consumed puffer fish about its local availability, their knowledge about its toxicity, any previous experience of eating it, where they bought the fish, and illness history. For people who died after consumption of the puffer fish, we used family members as proxy respondents to collect exposure and illness history. We also had informal discussions with community residents who lived near the case patients to explore their knowledge about puffer fish and collect information relating to its availability and source in the outbreak areas.

The investigating team visited Cox's Bazaar, one of the coastal areas of the country, and conducted in-depth interviews and informal group discussions with fish sellers, dry fish preparers, deep-sea fishermen, and community members to explore availability and trade of marine puffer fish and explore knowledge and perception related to puffer fish toxicity.

Data analyses. All quantitative data were entered and analyzed using SPSS 12 for Windows. We analyzed socio-demographic

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and clinical profiles of the case patients using descriptive statistics. All qualitative data were coded manually, and the qualitative investigators performed content analysis.

Ethics. All study participants gave verbal informed consent for participation in this investigation. This study was conducted as part of an outbreak investigation, and the study was approved by the Government of the People's Republic of Bangladesh (GoB).

RESULTS

Background information and demographics of case patients.

We investigated three different outbreaks in Narshingdi, Natore, and Dhaka Districts of the country reported during April and June 2008. These areas are inland and far from the coastal belt of the country (Figure 1). The outbreaks in Narshingdi and Natore were in rural areas, whereas the Dhaka

outbreak was in an urban setting. In total, we identified 95 people who had eaten puffer fish from the three outbreak areas. In Narshingdi, we identified 19 people, and 7 of them died. In Natore, 35 people developed symptoms, including 4 deaths. In Dhaka District, 9 of 11 people who consumed the fish developed symptoms, and 3 of them died. Their median age was 24 years (mean age = 24 years; standard deviation = 18 years), and 50 (53%) of them were male.

Clinical profile of case patients. Of the 95 identified people who had eaten the fish, 63 (66%) of them developed symptoms, and 14 (22%) of them subsequently died of intoxication. Among the 63 case patients, 32 (51%) of them were male, with a median age of 25 years. The duration between consumption of the fish and illness onset was 1–3 hours for 29 (46%) cases and less than 30 minutes for 14 (22%) cases; among those who died, nine (64%) died within 1 hour of consuming the fish (Figure 2). Case patients frequently reported tingling sensation

FIGURE 1. Map of Bangladesh showing Narshingdi, Natore, and Dhaka Districts and a coastal area (Cox's Bazaar).

FIGURE 2. Distribution of cases ($N = 63$) by duration between consumption of the fish and illness onset in Narshingdi, Natore, and Dhaka Districts.

in the body (91%), perioral numbness (68%), dizziness (64%), weakness in the limbs (60%), and nausea/vomiting (46%) (Table 1).

Size, local availability, and source of puffer fish. The outbreaks were caused by large marine puffer fish ranging from 0.2 to 1.5 kg (Figure 3). The fish were sold at US \$0.50–0.88/kg, whereas other types of fish of similar weight cost US \$1.50–1.76/kg. During our investigation, the community residents and local health authority in the outbreak area in Narshingdi District reported that they had not seen puffer fish in their village in the last 20–30 years. On the day of the outbreak, this large-size marine puffer fish arrived from one of the coastal areas to be sold in local markets. In Natore, small-size fresh water puffer fish are widely available in the village rivers and beels (water bodies), but community residents were unfamiliar with the larger variety of the marine puffer fish that was sold in the fish depot of the local market on the day of the outbreak. Although 62% of the respondents ($N = 65$) from Natore were not sure from where these larger puffers came, some (19%) believed that the fish had come from the coastal region of the country. In Dhaka, the fish were not purchased from a market, but a community waste cleaner collected five puffer fish from a community waste bin and brought them home for his family to eat.

Knowledge and practice relating to puffer consumption. In Narshingdi, none of our respondents ($N = 19$) had previous experience of eating the fish and were not aware of the potential intoxication from eating it. All of our respondents knew that the fish was puffer fish, because they were told this by the fish sellers. Similarly, in the Dhaka cluster, people who

FIGURE 3. Picture of puffer fish from the stock that caused the outbreak in Natore District.

consumed the fish ($N = 11$) knew it was puffer fish, because the community cleaner who distributed the fish told them; however, they were unaware of its toxicity and had no previous experience with eating fresh-water or marine puffer fish. The respondents (94%; $N = 65$) from Natore mentioned that they regularly enjoyed consuming the small, locally available fresh-water puffer fish, which are about the size of a finger, without becoming ill. Most of them were not familiar with the large puffer fish, and only 21 (32%) said they could identify the large fish that they were buying as puffer fish because of its similar appearance to the small river puffer fish.

Qualitative investigation of puffer fish trade in the coastal area. We conducted informal group discussions with one fish wholesaler, one dry-fish preparer, one deep-sea fishermen, and one community resident. We also conducted in-depth interviews with two fish wholesalers, three dry-fish preparers, two deep-sea fishermen, and five community members.

Deep-sea fishermen reported that they catch 4–5 species of puffer fish in the sea, each weighing between 0.2 and 3 kg (Figure 4). They consider puffer fish to be less valuable than other fish; local people do not eat the fish, because they know it is toxic. Fishermen do not usually sell puffer fish, but if their catch yields up to 20–30 kg of puffers, they may sell it to fish vendors in the wholesale market at US \$0.18–0.29/kg. The wholesalers, in turn, sell the fish to dry-fish preparers, who process the fish by removing the gall bladder, liver, intestines, and eggs, leaving only the skin and head with the flesh of the fish. Dried-fish vendors believe that the gall bladder and eggs of the fish contain the toxin and that discarding these parts makes the fish edible. The dried puffer fish is inexpensive and sold at US \$0.3/kg, compared with other dry fishes that

TABLE 1

Symptoms of the case patients after consumption of puffer fish from the three outbreaks in Narshingdi, Natore, and Dhaka Districts ($N = 63$)

Symptoms	<i>n</i> (%)
Tingling sensation	57 (91)
Perioral numbness	43 (68)
Dizziness	40 (63)
Weakness in the limbs	38 (60)
Nausea/vomiting	29 (46)
Headache	25 (40)

FIGURE 4. A catch of puffer fish in Cox's Bazaar.

are sold at US \$1.5–3/kg. Dried puffer fish is used as poultry feed and also consumed by ethnic people. Fish wholesalers reported that occasionally, when there is an abundant catch of puffer fish, some local fish businessmen and wholesalers distribute the fresh fish to different parts of the country, hoping to make a quick profit in areas where people are not familiar with the larger marine variety of puffer fish and are not aware of its toxicity.

DISCUSSION

The epidemiological data and typical clinical symptoms suggest that these outbreaks were almost certainly caused by consumption of marine puffer fish. Sporadic episodes of puffer poisoning have been documented in Bangladesh, but three consecutive outbreaks within 3 months highlight puffer fish intoxication as an important food-safety issue in Bangladesh. Although the three outbreaks occurred in three different places of the country, several features were common to all; the intoxications were caused by consumption of the larger marine variety of puffer fish, the three areas were far from the coastal regions of the country, and the affected communities were unfamiliar with the larger marine variety of the fish or its potential toxicity.

Investigation findings suggest that lack of knowledge about large marine puffer toxicity by persons who prepared and consumed the fish was an important contributing factor. Toxicological analyses of brackish-water puffer fish available in Bangladesh suggest that marine puffer fish are most likely to contain lethal quantities of tetrodotoxin.^{9,14} In addition, the larger variety of the fish that caused the outbreaks was novel in the affected communities. The sudden availability of a novel fish in the community also might have prompted the villagers to buy and eat the fish. In one of the affected villages, community residents had previously enjoyed consuming small, fresh-water puffer fish, which encouraged them to sample the larger variety.

Food insecurity and poverty may also have contributed to the outbreaks. In 2008, food prices in Bangladesh, including the staple foods rice and wheat, rose by 50–60%, leading to widespread scarcity just at the time that this new large fish became available at a comparatively affordable price.¹⁵ In Dhaka, the fish was actually retrieved from a community waste bin. Rising food prices coupled with poverty might have encouraged more frequent trade of this large marine puffer fish and tempted people to consume a fish that was not generally eaten.

One of the major limitations of the investigation is that we did not have the implicated fish identified by experts, because they were consumed or discarded by the time that the investigation team reached the outbreak site; however, the respondents' description of the fish typically matched with puffer fish, and the clinical features of illness were comparable with tetrodotoxin poisoning.^{3,9} Another limitation is that some of the case patients died before our investigation began, which might have obscured some of the exposure history. To ensure maximum reliability of information, we used multiple family proxy respondents for each of the deceased case patients. Also, people who developed symptoms after consumption of puffer fish may have been more likely to recall the event during intoxication than people who did not develop symptoms. Nevertheless, all respondents who had consumed the fish were

unaware of potential toxicity; our findings were consistent in all three of the outbreaks, and so, it is unlikely that there was any significant overreporting of symptoms of illness or consumption history.

In Bangladesh, fish are widely available and consumed. Lack of knowledge and awareness regarding poisonous aquatic species will predispose the area to future outbreaks. Efforts to prevent future intoxication should include wider dissemination of public-health messages using audio-visual mass media such as radio, television, electronic print media, and staging folk song. These messages should describe the appearance, symptoms of intoxication, and the possible fatal outcomes of consuming puffer fish so that communities can identify cases of puffer fish intoxication and seek prompt medical care. Improved awareness among fish sellers and fish distributors may impact the occasional trade of the fresh puffer fish. Further exploration of the trade and consumption pattern of the fish will help refine these health messages.

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