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Food-Symptomatology Questionnaires: Risks of Demand-Bias Questions and Population-Biased Surveys

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The "Chinese restaurant syndrome" (CRS) is reportedly characterized by a unique symptom complex consisting of sensations variously described as "burning," "tightness," and/or "numbness" in the upper chest, neck, and face, beginning shortly after the start of a meal in a Chinese restaurant and lasting less than 4 hr (1–4). Less characteristic symptoms include dizzyness, headache, chest pain, palpitation, weakness, nausea, and vomiting (2,7). The syndrome has been speculated to be caused by the flavor enhancer monosodium glutamate (MSG), and Reif-Lehrer (5,6) recently reported that some 25% of a population surveyed by questionnaire may have experienced this condition.

Being concerned that "demand-bias" in the Reif-Lehrer questionnaire resulting from use of the question "Do you think you get 'Chinese restaurant syndrome?' " might have led to an exaggerated estimate of its true prevalence, we recently attempted to clarify the issue through a two-part questionnaire (3). The first part attempted to identify unpleasant symptoms associated with particular foods and places of eating, but did *not* include the phrase "Chinese restaurant syndrome." When the first questionnaire was completed, the same respondents received a second asking if they had ever heard of a "Chinese restaurant syndrome," what symptoms were associated with it, and whether they had personally experienced it. The questionnaires were administered to students of the Harvard Summer School, faculty, students, and staff of the Harvard School of Public Health, and employees of the Children's Hospital Medical Center of Boston. The study revealed that 3 to 7% reported symptoms on the first questionnaire that could possibly represent the characteristic syndrome, yet once the syndrome was mentioned, 31% believed that they had experienced it. We concluded that nonspecific symptoms that occurred in association with eating in Chinese restaurants were erroneously believed to represent the "Chinese restaurant syndrome" by those familiar with its name.

Because of the additional concern that data derived from this "health-conscious" sample might not be representative of the general population, Market Research

Corporation of America (MRCA) was commissioned by Ajinomoto, U.S.A. to administer the same questionnaire sequence to its National Consumer Panel.

MATERIALS AND METHODS

Study Population

The National Consumer Panel is a panel of households that report to MRCA their purchases of grocery and textile products. The sample is maintained at a level of about 7,500 active reporting households, generally representative of the United States and stratified by demographic characteristics such as household size, region, age of housewife, and so on. For the present study, a subsample of 2,269 households was selected at random from within each strata. Each of the 4,729 adult members of the 2,269 households received both study questionnaires.

Questionnaire Design

Questionnaire I stated that we were collecting information on the symptoms and discomforts that some people associate with particular foods. Subjects were told that a second questionnaire dealing with their knowledge of a particular food-associated health problem would be sent to those who completed the first one. Questionnaire I listed 18 food-associated symptoms, 3 of which were characteristically associated with CRS (burning sensation in the face or chest, tight sensation around face, neck or chest, and numbness or loss of feeling). Six symptom options were nonspecific, but often associated with CRS (chest pain, dizziness or light headedness, headache, nausea or vomiting, palpitation, and weakness), and 9 options were even more nonspecific or not associated with CRS (abdominal cramps, chills, diarrhea, flushing sensation in face or chest, heartburn, unusual perspiration or sweating, unusual thirst, tingling, and others to be specified). Respondents were asked the time of onset of each symptom after the start of the meal (options: under 10 min, 10 min to 2 hr, over 2 hr) and its duration (options: less than 1 hr, 1 to 4 hr, over 4 hr).

Having identified the unpleasant symptoms associated with food, we then questioned whether each was notably associated with a particular food class from a list of 15 options that included beverages, cereal or grain products, chocolates or other "sweets," dairy products, desserts, eggs or egg products, fowl or poultry, fruits or fruit juices, meats, nuts, seafood and shellfish, soups, spices, vegetables, and others (specify). Respondents were then asked if each symptom was associated with a particular place of eating from a list of 11 options that included cafeterias, church suppers, delicatessens, fast-food restaurants, hotels, lunch counters, personal residence, picnics, residence of friends, restaurants, and vendors and vending machines.

We then asked if each symptom was notably associated with a particular ethnic style of food preparation from a list of 15 options that included American, Arabic, Chinese, French, German, Greek, Hungarian, Indian, Japanese, Jewish, Mexican-Spanish, Polynesian, Scandinavian, "soul food," and others (to be specified). And

finally, we asked if each symptom was associated with a particular ethnic food course from a list of 15 options that included chow mein, curry, gefilte fish, goulash, hot dog, pizza, raw fish (sashimi), salad (type to be specified), shish kebab, soup (type to be specified), spaghetti, sweet-and-sour pork, tempura, taco, and others (to be specified).

Questionnaire II contained an initial series of questions that again related to unpleasant symptoms that respondents might associate with specific foods or eating environments. We then asked whether they personally ate foods prepared in Chinese restaurants (including "take-outs"); whether they purchased Chinese food in markets or prepared Chinese food at home; whether they had ever heard of a condition called "the Chinese restaurant syndrome"; which of 18 symptoms (the same symptoms options listed in Questionnaire I) were believed to be associated with the syndrome; what the temporal relationships were between the symptoms and consumption of food in Chinese restaurants (the same time options as in Questionnaire I); whether the respondent had personally experienced CRS (options: yes, no, don't know); and whether the syndrome was associated with a particular food additive from a list of nine options that included artificial food colors, artificial food flavors, artificial sweeteners, BHA, BHT, iodized salt, MSG—monosodium glutamate, sodium nitrate, sodium nitrite, spices (to be specified), and other (to be specified).

Data Analysis

Data were analyzed by computer, using a proprietary data processing system. In determining the prevalence of CRS, symptoms commencing sooner than 10 min, later than 2 hr after the start of the meal, or having a duration greater than 4 hr were not considered compatible with characteristic CRS. Each of the three characteristic CRS symptoms ("burning," "tightness," and "numbness") were given a score of from 1 to 3 depending on their presence, time of onset, and duration. If a correspondent reported a characteristic CRS symptom but failed to report times of onset and duration and indicated that it was an uncommon occurrence, we gave the benefit of the doubt and assumed that the times would have been those characteristic of CRS. If a respondent identified only one of the characteristic symptoms, with the appropriate times of onset and duration, a score of 3 was allocated; all three symptoms with correct times of onset and duration would receive a score of 9. The symptoms reported were then scored with a range from 0 to 9 according to the following system: 0 = not CRS; 1 to 2 = probably not CRS; 3 to 6 = possibly CRS; 7 to 8 = probably CRS; and 9 = definitely CRS. A response reporting one characteristic symptom with the correct temporal associations would be considered a "possible CRS."

RESULTS

Both questionnaires were completed by 3,222 respondents. Thirty-seven percent of the 1,411 male respondents were 18 to 34 years of age; 32% were 35 to 54; and 31% were over 55. Of the 1,811 female respondents 32, 30, and 38% were in the same age ranges.

TABLE 1. *Unpleasant symptoms associated with food*

Symptom	% Sample reporting symptom	% Male	% Female	% "Correct" onset time	% "Correct" duration
Abdominal cramps	10.7	8.6	12.3	56.1	30.8
Burning sensation in face or chest	2.3	2.4	2.2	36.5	12.2
Chest pain	3.2	3.6	2.9	44.7	23.3
Chills	1.2	0.8	1.6	17.5	5.0
Diarrhea	12.1	10.1	13.6	47.9	36.7
Dizziness	2.9	2.6	3.2	42.6	22.3
Flushing sensation in face or chest	1.9	1.2	2.5	24.2	9.7
Headache	4.8	3.8	5.6	31.6	38.7
Heartburn	24.5	24.9	24.2	64.6	31.9
Nausea or vomiting	6.4	5.1	7.3	43.4	31.7
Numbness or loss of feeling	1.2	1.0	1.3	21.1	15.8
Palpitation	2.0	1.0	2.8	36.9	18.5
Tight sensation around face, neck, or chest	1.3	0.9	1.5	34.1	19.5
Tingling	1.3	0.9	1.6	16.7	11.9
Unusual perspiration	3.6	4.2	3.1	30.4	12.2
Unusual thirst	10.4	9.6	11.0	53.3	38.9
Weakness	1.8	1.2	2.2	40.4	17.5
Other	4.0	3.0	4.8	39.5	24.8

Questionnaire I

A total of 1,369 respondents, 43% of the total sample, indicated that one or more unpleasant symptoms were associated with the consumption of food. Twenty percent reported experiencing only 1 of the 18 symptom options; 10% reported 2 symptoms; 5% reported 3 symptoms, with progressively smaller numbers of respondents reporting additional symptoms. Two respondents reported all 18 symptom options.

The frequency of individual symptoms is presented in Table 1. It is apparent that nonspecific symptoms of "heartburn," diarrhea, abdominal cramps, and unusual thirst are experienced by over 10% of the study population. The characteristic CRS symptoms of "burning," "numbness," and "tight" sensation were reported by 2, 1, and 1% of the population, respectively. Headache was reported by nearly 5%, unusual perspiration by 4%, and the other CRS-associated symptoms by smaller percentages of the study sample. A larger percent of females reported experiencing 14 of the 18 symptom options. Many respondents did not report times of onset and duration of symptoms; of those that reported these times, the percent falling within the "acceptable" limits of CRS is also indicated in Table 1. It is apparent that many of the symptoms—CRS-characteristic, CRS-associated, and nonspecific—are experienced within the same periods of time.

On the basis of our scoring system, none of the respondents reported all three characteristic CRS symptoms within the correct time limitations (score 9) nor did

TABLE 2. *Specific food classes associated with symptoms*

Food class	% Positive association	% Positive respondents reporting		
		Characteristic CRS symptoms (total of 3)	CRS-associated symptoms (total of 6)	Nonspecific symptoms (total of 9)
Beverage	10.5	4.4	32.9	81.5
Cereal products	2.0	7.4	14.8	90.7
Chocolate or "sweets"	6.9	5.4	32.5	79.8
Dairy products	3.7	3.7	21.1	89.0
Desserts	3.7	4.0	25.0	89.0
Egg products	3.4	7.4	18.9	88.4
Fowl/poultry	1.5	4.7	23.3	83.7
Fruit/fruit juice	6.4	5.3	8.0	95.7
Meats	8.8	2.7	20.4	90.2
Nuts	5.5	3.9	24.2	86.9
Seafood and shellfish	3.8	3.7	21.1	89.0
Soups	3.4	4.2	11.5	94.8
Spices	18.1	4.9	12.3	94.7
Vegetables	8.3	3.4	11.3	94.5
Others	6.6	4.6	17.5	90.2

Many respondents reported more than one symptom.

any report symptoms that met the criteria for "probable CRS" classification (scores 7 to 8). Fifty-seven respondents, 25 males and 32 females (1.8% of the total study population), reported symptoms that were classed as "possible CRS" (scores 3 to 6). Of these 57 respondents, 46 reported only one of the characteristic symptoms; they also reported one (17 of the 57) or more (40 of the 57) CRS-associated symptoms, and 50 of the 57 reported one or more nonspecific symptoms.

The food classes associated with specific symptoms are presented in Table 2. Eighteen percent of the respondents reported unpleasant experiences with "spices," but all other options were selected by 10% or less of respondents. Characteristic CRS symptoms were noted by from 2 to 8% of those respondents who reported unpleasant symptoms for each option. CRS-associated symptoms were indicated for each food class by from 8 to 32%, and 80% or more of the unpleasant symptoms associated with each food were of the nonspecific category. Symptoms associated with "spices" had the following frequency sequence: "heartburn," 65%; unusual thirst, 15%; abdominal cramps, 13%; diarrhea, 9%; and unusual perspiration, 7%. No particular food group was clearly associated with characteristic CRS symptoms.

The places of eating that were associated with unpleasant symptoms are presented in Table 3: 15% of respondents reported unpleasant symptoms after meals eaten in their own residence; 11% after meals in restaurants; 9% after eating in fast-food restaurants; and 7% after meals in the residence of friends. Other options were selected by progressively fewer respondents, with only 2% reporting unpleasant symptoms after church suppers. Over 90% of the symptoms associated with each option were of the nonspecific category; 18 to 25% of symptoms were related to CRS-associated symptoms; and 4 to 9% of symptoms were considered characteristic

TABLE 3. *Eating places associated with unpleasant symptoms*

Eating place	% Positive association	% Positive respondents reporting		
		Characteristic CRS symptoms	CRS-associated symptoms	Nonspecific symptoms
Cafeterias	4.5	5.3	22.9	92.4
Church suppers	1.9	8.8	21.1	91.2
Delicatessens	2.5	3.9	15.8	96.1
Fast-food restaurants	8.5	5.9	19.5	94.5
Hotels	2.0	6.5	22.6	93.5
Lunch counters	3.6	3.7	18.7	96.3
Personal residence	14.8	5.6	22.1	93.0
Picnics	4.0	5.1	17.8	94.1
Residence of friends	6.9	6.2	21.5	94.7
Restaurants	11.2	6.2	22.1	90.6
Vendors and vending machines	2.7	6.3	25.3	91.1

TABLE 4. *Ethnic styles of food preparation associated with unpleasant symptoms*

Food style	% Positive association	% Positive respondents reporting		
		Characteristic CRS symptoms	CRS-associated symptoms	Nonspecific symptoms
American	10.9	2.8	22.4	95.0
Arabic	0.3	0	10.0	100.0
Chinese	4.2	9.1	18.9	87.9
French	1.3	11.1	13.9	94.4
German	1.7	5.7	17.0	96.2
Greek	1.2	5.7	11.4	97.1
Hungarian	1.0	3.3	10.0	96.7
Indian	1.3	10.3	5.1	97.4
Italian[a]	5.1	6.6	13.8	96.1
Japanese	1.1	8.6	11.4	94.3
Jewish	0.9	4.2	8.3	100.0
Mexican-Spanish	14.9	5.5	11.5	96.7
Polynesian	1.0	17.2	6.9	89.7
Scandinavian	0.2	0	0	100.0
"Soul food"	1.3	5.9	17.6	91.2
Other	1.2	6.2	15.6	84.4

[a] Extracted from the category of "other."

of CRS. No particular place of eating was notably associated with characteristic CRS symptoms. Of the 57 respondents who were classified as "possible CRS," 40% reported CRS symptoms after eating in restaurants, and 40% reported CRS symptoms after eating in their personal residence.

The ethnic styles of food preparation associated with unpleasant symptoms are presented in Table 4. Some 15% of respondents associated unpleasant symptoms with Mexican-Spanish foods; 11% with American; 4% with Chinese food; and

TABLE 5. *Symptoms most often reported after eating different ethnic styles of food*

	1 (% Symptoms reported)	2 (% Symptoms reported)	3 (% Symptoms reported)
American	Heartburn (57.4)	Diarrhea (27.8)	Cramps (25.2)
Arabic	Heartburn (60.0)	Cramps (40.0)	Diarrhea, thirst, nausea, vomiting other (10.0 each)
Chinese	Heartburn (37.1)	Thirst (34.8)	Diarrhea (13.6)
French	Heartburn (66.7)	Cramps (25.0)	Diarrhea (22.2)
German	Heartburn (69.8)	Cramps (28.3)	Thirst (18.9)
Greek	Heartburn (62.9)	Cramps (31.4)	Diarrhea, thirst (17.1 each)
Hungarian	Heartburn (63.3)	Cramps (26.7)	Diarrhea (20.0)
Indian	Heartburn (51.3)	Thirst (28.2)	Cramps (17.9)
Italian	Heartburn (70.4)	Thirst (20.4)	Cramps (17.1)
Japanese	Heartburn (34.3)	Thirst (31.4)	Diarrhea (28.6)
Jewish	Heartburn (58.3)	Thirst (37.5)	Diarrhea (16.7)
Mexican-Spanish	Heartburn (68.1)	Thirst (19.2)	Cramps (18.1)
Polynesian	Heartburn (41.4)	Thirst, diarrhea (20.7 each)	Thirst, diarrhea (20.7 each)
Scandinavian	Thirst (66.7)	Cramps, heartburn, diarrhea (16.7 each)	Cramps, heartburn, diarrhea (16.7 each)
"Soul food"	Heartburn (55.9)	Cramps (32.4)	Diarrhea (26.5)
Other	Heartburn (40.6)	Thirst (21.9)	Diarrhea, other (12.5 each)

progressively fewer positive responses with other options, down to 0.2% with Scandinavian food. While Italian food had not been listed as an option, over 5% of respondents associated unpleasant symptoms with Italian food under the "other" option. Over 80% of unpleasant symptoms associated with each ethnic cuisine were of the nonspecific category, and from 0 to 22% of symptoms were CRS-associated. Characteristic CRS symptoms were reported by 17% of those reporting unpleasant symptoms after eating Polynesian food and by 11% of those experiencing unpleasant symptoms after either French or Indian foods. (The characteristic CRS symptom most often associated with these three ethnic styles of preparing food was a "burning sensation," but CRS symptoms were also reported by 5 to 10% of those reporting difficulty after Chinese, German, Greek, Italian, Japanese, Mexican-Spanish, "soul food," and other ethnic styles of food preparation, and in each case a "burning sensation" was the most common symptom.) Of the 57 "possible CRS" respondents, only 6 (0.019% of the study population) reported characteristic CRS symptoms after consuming Chinese food.

Table 5 presents the three unpleasant symptoms most commonly associated with each of the ethnic styles of preparing food. With the exception of Scandinavian food, where unusual thirst was the most common complaint, heartburn was the most frequent symptom in all cases. The next most common symptoms were those of abdominal cramps, diarrhea, and unusual thirst. No particular ethnic style of food preparation was associated with a uniquely different pattern of symptoms.

TABLE 6. *Unpleasant symptoms associated with particular ethnic foods*

Food	% Positive association	% Positive respondents reporting		
		Characteristic CRS symptoms	CRS-associated symptoms	Nonspecific symptoms
Chow mein	2.5	10.1	21.5	87.3
Curry	2.8	9.5	8.3	95.2
Gefilte fish	0.4	11.1	0	100.0
Goulash	3.0	5.4	8.6	96.8
Hot dogs	7.4	2.2	15.2	94.2
Pizza	12.0	3.9	10.5	96.1
Raw fish (sashimi)	0.2	0	71.4	28.6
Salad	3.4	1.0	13.6	94.2
Shish kebob	0.8	4.3	8.7	100.0
Soup	3.1	3.5	8.1	97.7
Spaghetti	8.3	4.9	11.3	96.0
Sweet-and-sour pork	2.8	4.8	22.9	90.4
Tempura	0.3	0	22.2	88.9
Taco	9.7	4.4	8.8	97.3
Other	4.0	5.6	13.7	92.7

Specific ethnic foods associated with unpleasant symptoms are presented in Table 6. Pizza was associated with unpleasant symptoms by 12% of respondents, tacos 10%, spaghetti 8%, hot dogs 7%, and the other ethnic food options were associated with unpleasant symptoms by progressively fewer respondents. With the exception of the "raw fish" option, over 80% of the symptoms reported were of the nonspecific variety. CRS-associated symptoms accounted for 71% of the "raw fish" symptoms (mainly nausea and vomiting) and for 0 to 23% of the symptoms associated with other ethnic foods. Characteristic CRS symptoms accounted for 10% of unpleasant symptoms reported after chow mein and gefilte fish, but for less than 6% of symptoms associated with other ethnic food options. Of those classified as "possible CRS" on the basis of their symptoms, eight associated characteristic CRS symptoms with pizza, six with tacos, five each with spaghetti and "other," and four each with chow mein, hot dogs, and goulash.

Table 7 reports the three unpleasant symptoms most commonly associated with specific ethnic foods. With the exception of sashimi (where 71% of positive responses reported nausea or vomiting) and chow mein (where thirst was the most prominent symptom), heartburn was the primary complaint in all instances. The next most common complaints were, in almost all instances, those of abdominal cramps, diarrhea, and thirst. As with the preceeding questions, and with the exception of the "raw fish" option, it did not appear that any of the ethnic food options was associated with a unique pattern of unpleasant symptoms.

Questionnaire II

After receiving the above information without use of the leading phrase "Chinese restaurant syndrome," the second questionnaire attempted to ascertain the number of respondents aware of it, its symptoms, and who had personally experienced it.

TABLE 7. *Symptoms most often reported after eating different ethnic foods*

Food	1 (% Symptoms reported)	2 (% Symptoms reported)	3 (% Symptoms reported)
Chow mein	Thirst (38.0)	Heartburn (35.4)	Cramps, diarrhea (15.2 each)
Curry	Heartburn (58.3)	Cramps, thirst (19.0 each)	Thirst, cramps (19.0 each)
Gefilte fish	Heartburn (44.4)	Cramps, diarrhea, thirst (22.2 each)	Cramps, diarrhea, thirst (22.2 each)
Goulash	Heartburn (74.2)	Cramps (16.1)	Diarrhea (12.9)
Hot dog	Heartburn (66.4)	Cramps (18.4)	Thirst (15.2)
Pizza	Heartburn (68.4)	Thirst (21.9)	Cramps (14.1)
Raw fish (sashimi)	Nausea, vomiting (71.4)	Cramps, diarrhea, unusual perspiration (14.3 each)	Cramps, diarrhea, unusual perspiration (14.3 each)
Salad	Heartburn (64.1)	Cramps (26.2)	Diarrhea (17.5)
Shish kebab	Heartburn (69.6)	Cramps (21.7)	Thirst (13.0)
Soup	Heartburn (60.5)	Cramps (20.9)	Thirst (17.4)
Spaghetti	Heartburn (73.7)	Cramps (17.4)	Thirst (15.4)
Sweet-and-sour pork	Heartburn (50.6)	Thirst (26.5)	Diarrhea (20.5)
Tempura	Heartburn, diarrhea (44.4 each)	Heartburn, diarrhea (44.4 each)	Cramps (33.3)
Taco	Heartburn (68.4)	Thirst (20.5)	Cramps (16.2)
Other	Heartburn (49.2)	Cramps (24.2)	Diarrhea, thirst (19.4 each)

Chinese food was consumed with a wide range of frequency, with 31% stating that they ate in Chinese restaurants more often than once or twice a year. About 20 to 22% of the respondents reported the purchase or home preparation of Chinese food more often than once or twice a year. Of "possible CRS" respondents, 3% stated they never or rarely ate in Chinese restaurants; 4% stated they ate there more often than once or twice a year. Of respondents reporting one or more characteristic CRS symptoms, 8% never or rarely ate at Chinese restaurants; 13% ate there more often than once or twice a year.

Only 8% of respondents reported that they had heard of a condition called the "Chinese restaurant syndrome," 86% were unfamiliar with the phrase, and 6% gave no response. The symptoms associated with CRS by those who were "aware" of it are reported in Table 8. Headache was the most common symptom (38%), followed by unusual thirst (31%), dizziness (29%), abdominal cramps (20%), diarrhea (21%), flushing (22%), and heartburn (18%). The characteristic CRS symptoms were identified by a smaller number of respondents: "burning" (11%); "numbness" (11%), and "tight" sensation (12%). Thirty-one percent of those aware of the syndrome stated that "burning," "tightness," and "numbness" were *not* associated with CRS, and approximately 60% of those "aware" reported they "didn't know" or gave no response to each symptom option. Of the total panel, 2% were "aware" of CRS and able to identify at least one of its characteristic symptoms; 5% were "aware," reporting CRS-associated symptoms; and 5% were "aware," reporting nonspecific symptoms.

When queried as to the food additive associated with the syndrome, 8% of the

TABLE 8. *Symptoms associated with CRS by respondents familiar with name of syndrome*

Symptom	Yes (%)	No (%)	Don't know (%)	No response (%)
Abdominal cramps	20.2	27.1	26.7	26.0
Burning	11.2	31.0	27.9	29.8
Chest pain	8.5	34.1	28.3	29.1
Chills	5.8	37.6	28.7	27.9
Diarrhea	20.5	26.7	26.4	26.4
Dizziness	29.1	23.6	22.5	24.8
Flushing	22.1	24.8	24.8	28.3
Headache	37.6	19.8	21.7	20.9
Heartburn	18.2	27.5	27.5	26.7
Nausea or vomiting	15.9	30.2	26.7	27.1
Numbness	10.9	31.0	27.5	30.6
Palpitations	15.1	30.2	25.6	29.1
Thirst	30.6	23.3	24.0	22.1
Tightness	12.4	31.0	27.5	29.1
Tingling	4.3	34.9	29.8	31.0
Unusual perspiration	14.0	29.8	27.1	29.1
Weakness	9.7	32.9	26.7	30.6
Other	1.9	15.5	18.6	64.0

panel associated it with MSG; other additives were identified by only 1 to 2% of respondents. The majority of respondents "didn't know" or were "unaware" of any association between specific food additives and CRS.

With regard to the prevalence of CRS, 65 respondents or 2.0% of the study population reported that they had personally experienced the syndrome. Forty percent of the respondents stated they had not experienced it; 43% "didn't know," and 15% failed to answer the question. Because of a concern about the legibility of the answer options to the "Have you personally experienced the Chinese restaurant syndrome?" question, a repeat questionnaire was sent to 98 respondents who had stated they were aware of the CRS and had *not* expressed it. Nine of the 98 subsequently reported personal experience with CRS, resulting in a *subjective* prevalence rate of 74/3222 or 2.3%. Of these 74, however, only 6 had been classified as "possible CRS" on the basis of their symptoms.

Finally, of respondents who reported personal experience with CRS, 69% stated that they ate in Chinese restaurants more often than once or twice a year; 29% stated that they never or rarely ate at Chinese restaurants. Of respondents who reported they did *not* experience CRS, the figures were almost reversed: 70% never or rarely ate in Chinese restaurants, and 28% ate there more often than once or twice a year.

DISCUSSION

Webster's New Collegiate Dictionary defines *syndrome* as "a group of signs or symptoms that occur together and characterize a particular abnormality." The original reports of CRS described a symptom complex that was characteristic and unique. Subsequent reports have included an increasing number and variety of

symptoms, however, and the original definition of syndrome has been modified by Rief-Lehrer to include any symptoms named in response to the question "Do you get any of the symptoms below (20 options including 'other') after you eat Chinese restaurant food either in restaurants or 'take out?' " "Other" symptoms reported included "depression," "detachment," "feel emotionally variable; laughing, crying," "sense of fullness after a limited amount of food," "water retention," and 31 other new symptoms, all of which now become components of a newly defined CRS.

It would appear reasonable to expect that a syndrome postulated to result from the pharmacologic effects of an agent should have limited interindividual variance: inclusion of nonspecific or noncharacteristic symptoms as components of a syndrome will detect "atypical" cases, but will also result in a larger, and more likely erroneous, estimate of its prevalence in a population. If carried to the absurd, an individual who consistently suffers the headache, thirst, weakness, and nausea of hangovers from overconsumption of rice wine in Chinese restaurants might logically conclude that he was susceptible to CRS.

Although we do not dispute that some people have developed a dramatic and frightening syndrome after eating in Chinese restaurants, we believe that the prevalence rates of 25% reported by Reif-Lehrer (5,6) and the 3 to 7% reported by Kerr et al. (3) are probably both in excess of the true figure. The basis for the different estimates of prevalence involves important issues of questionnaire design and administration. The fact that Reif-Lehrer's reports were published as "Special Articles" in the prestigious *Federation Proceedings* suggests a need to review some of these issues.

It is clear, for example, that many people have strong feelings about particular foods and welcome the opportunity to report such feelings. It is also well established that individuals who return questionnaires are usually more interested in the subject matter than those who do not. Analyses of food-associated questionnaire data must consider whether those who returned the questionnaire "wanted" to participate and whether their responses are representative of the entire population. This is a difficult problem to resolve except through some form of remuneration or non-food-associated reward system.

A second concern is that of "demand-bias" from leading questions. Questionnaires should minimize the risk that respondents may become aware of the actual issue and want to "help" the study. Rief-Lehrer's questionnaire included "Do you think you get Chinese restaurant syndrome?" And we believe this question may have led some of her study population to report non-CRS symptoms as instances of the syndrome. Properly designed questionnaires must go to great lengths to prevent the researcher's own interest or biases from being communicated to respondents. By addressing these two concerns in questionnaires, we were able to reduce the apparent prevalence of the CRS from 25 to 3 to 7%.

A third concern involves population bias: both Reif-Lehrer's study and our previous one were conducted in a population strikingly different from the general population. In both cases the participants were more "health-aware" than the

general population, more likely to be familiar with the expression "Chinese restaurant syndrome," and thus more likely to report an exaggerated estimate of its prevalence. For example, 92% of our Harvard population associated unpleasant symptoms with food, compared with 43% of the present study population. From 2 to 9 times as many Harvard respondents reported experiencing each of the symptom options, and 31% believed they had experienced CRS compared with 2% of the general adult population. And where our previous prevalence estimate (based on the symptoms reported by the Harvard population) was in the range of 3 to 7%, the symptoms reported by the present National Consumer Panel suggest that 1 to 2% of the adult population experience symptoms that might possibly represent CRS.

An additional methodologic concern involves "exposure." People who do not eat in Chinese restaurants may not believe that they had experienced CRS even though they may have developed the appropriate symptoms in another eating environment. Conversely, individuals who frequently eat in Chinese restaurants would be more liable to have experienced some unpleasant event, in some temporal relationship with the meal, that might suggest that it was CRS rather than gastroenteritis, overindulgence, or some discomfort associated with the event or the eating environment rather than the food consumed.

And finally, we believe that a syndrome, if it is a true entity, and particularly if it is caused by a pharmacologic agent, must show reasonable conformity to its characteristic symptom complex. It is apparent from both our previous and current questionnaires that many people associate unpleasant signs and symptoms with specific foods and eating environments. In the great majority of cases these symptoms are nonspecific, and any questionnaire attempting to document the prevalence of a food-associated health problem must minimize the risk of such nonspecific symptoms being given undue significance. While 74 respondents (3.2% of the study population) reported that they had personally experienced CRS, only 6 of them were classified as "possible CRS" on the basis of their symptoms. Accordingly, some attempt must be made, in food-symptomatology questionnaires, to modify prevalence estimates resulting from *subjective* feelings by some *objective* criteria.

There are still many unresolved issues in regard to the true prevalence of CRS, and we hope the present study will lead to further refinements in questionnaire design. For example, many of these symptoms are ambiguous and imprecise: it is possible that the characteristic CRS symptom of "numbness" may have been reported by some as nonspecific "tingling" and that the characteristic symptom of "burning" was interpreted as nonspecific "flushing" (or vice versa). For the present, however, we chose not to speculate on respondent's interpretation of these words, as both "burning" and "flushing" may possibly be confused with the *normal* feeling of "warmth" accompanying the ingestion and metabolism of food.

The data from this study suggest that the characteristic symptoms of CRS, which may (and more often do not) occur in association with food consumption in a Chinese restaurant, has a prevalence rate of somewhere closer to 1 to 2% of the general adult public than either of the previous estimates of 3 to 7 and 25%.

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