

## RESEARCH LETTERS

**Sodium Content of Lunchtime Fast Food Purchases at Major US Chains**

Cardiovascular disease is the leading cause of death in the United States,<sup>1</sup> and high blood pressure is a leading risk factor. An extensive body of research describes a direct association between sodium intake and blood pressure.<sup>2</sup> Current US recommendations advise adults to limit sodium intake to less than 2300 mg/d,<sup>3</sup> and several demographic groups (blacks, middle-aged and older adults, and people with hypertension), which together compose 69% of US adults,<sup>4</sup> to limit daily intake to 1500 mg. Despite these suggestions, adults consume an average of approximately 3500 mg of sodium per day.<sup>5</sup>

Individual efforts to reduce sodium intake have limited effect, likely because more than 75% of dietary sodium comes from packaged and restaurant foods.<sup>6</sup> The American Medical Association has called on industry to reduce the sodium content of processed and restaurant foods by 50%. A reduction by this amount would save tens of thousands of lives each year,<sup>7,8</sup> and this reduction could save almost \$20 billion in health care costs annually.<sup>8</sup>

There are limited published data on the relationship between restaurant food and sodium intake. Using data from a large cross-sectional survey of patrons exiting fast food chain restaurants in New York City (NYC),<sup>9</sup> we assessed the amount of sodium in meal purchases by fast food chain and by chain category.

**Methods.** All NYC fast food chains licensed by the NYC Department of Health and Mental Hygiene that provided nutrition information publicly as of March 1, 2007, were considered for inclusion in the study. When ice cream chains were excluded, 13 chains composed almost 90% of all eligible restaurants. From approximately 1625 eligible locations across the 5 boroughs of NYC, a random sample of 300 chain restaurants was selected. Eleven fast food chains and 2 coffee chains were represented; the 2 coffee chains were excluded from our analysis.

Data were collected from noon to 2:00 PM on weekdays from March 27 to June 8, 2007. Adult patrons (age  $\geq 18$  years) exiting the restaurant answered a brief survey and provided their purchase receipt in exchange for a \$2 MetroCard.

Nutrition information was ascribed to each menu item using information posted on company Web sites as of March 1, 2007. A meal was defined as any purchase with

at least 1 entrée. An entrée was defined as any item that was not a side order (eg, French fries, side salad) or a dessert.

To examine the distribution of sodium content, meals were categorized by sodium level: 600 mg or less, 601 to 1499 mg, 1500 to 2299 mg, and 2300 mg or greater. To assess the relationship between calorie and sodium intake, we calculated sodium density, defined as milligrams of sodium per 1000 calories.

SPSS 15.0 software (SPSS Inc, Chicago, Illinois) was used for statistical analyses. A 2-tailed *t* test ( $\alpha$  level  $< .05$ ) was used to test for differences in mean sodium levels. For bivariate tables, the  $\chi^2$  test was used to obtain *P* values.

**Results.** The final sample size for the analysis of fast food meals was 6580 receipts from 167 locations, after purchases without entrees were excluded ( $n=466$ ). Meals averaged 1751 mg of sodium; 20% had greater than 2300 mg. At fried chicken chains, 55% of meals had more than 2300 mg of sodium, which was higher than the mean percentage at all chains ( $P < .001$ ). Fried chicken chain meals averaged 66 more calories than burger chain meals (999 calories vs 933 calories;  $P = .007$ ) but contained almost 900 mg more sodium (2441 mg vs 1548 mg;  $P < .001$ ). Over half (57%) of all purchases exceeded the 1500-mg recommended daily sodium limit applicable to most Americans, this rose to 84% in fried chicken chains. Mean sodium density for all meals purchased was 2136 mg per 1000 calories (**Table**).

**Comment.** This study extends analyses of the nutritional content of fast food from calorie to sodium content and shows that fast food is high in sodium as well as calories. Only 1 in 36 purchased meals met the Food and Drug Administration "healthy" sodium level for meals (600 mg), whereas 1 in 5 exceeded the recommended daily limit (2300 mg). Excess sodium intake was not simply the result of large portion size. Average sodium density was 2136 mg sodium per 1000 calories purchased, so even a patron who was mindful of calorie intake would likely exceed standards for healthy sodium intake.

Fast food is an important and growing contributor to dietary intake. Chain restaurant visits, both fast food and casual dining, now represent almost 75% of all restaurant eating occasions.<sup>10</sup> However, reducing sodium content in fast food is possible and already under way in some settings. The United Kingdom has worked with fast food chains to obtain commitments to sodium reductions<sup>11</sup>; in 2004, McDonald's committed to a 30% sodium reduction in its chicken nuggets. The National Salt Reduction Initiative in the United States, coordinated by the NYC Health Department, is now working with the restaurant industry to define sodium targets and to secure industry commitments to reductions.

**Table. Mean Sodium, Mean Calories, Mean Sodium Density, and Percentage of Meals by Sodium Content at 11 New York City Fast Food Chains by Collection of Consumer Receipts<sup>a</sup>**

Fast Food Chain	Valid Receipts	Mean (SE)			Meals by Sodium Content, %			
		Sodium, mg	Calories	Sodium Density, mg/1000 kcal	≤600 mg	601-1499 mg	1500-2299 mg	≥2300 mg
Total meals	6580	1751 (27.1)	881 (11.8)	2136 (33.5)	2.8	40.4	36.4	20.4
Burger chain	3350	1548 (16.8)	933 (10.8)	1780 (12.9)	3.2	46.4	38.9	11.5
Burger King	850	1685 (28.4)	1008 (16.6)	1727 (15.0)	5.5	33.3	44.6	16.6
McDonald's	2107	1477 (17.7)	908 (13.6)	1782 (17.4)	2.8	51.7	36.1	9.3
Wendy's	393	1631 (34.6)	907 (27.7)	1885 (34.7)	0.0	46.6	41.5	12.0
Sandwich chain	1883	1859 (31.9)	757 (14.2)	2643 (24.4)	1.9	37.9	36.5	23.7
Au Bon Pain	140	1553 (25.6)	608 (12.2)	2842 (116.7)	16.4	37.9	25.7	20.0
Subway	1743	1883 (30.2)	768 (13.1)	2627 (23.4)	0.7	37.9	37.3	24.0
Fried chicken chain	585	2441 (47.5)	999 (21.8)	2466 (34.2)	1.7	14.5	28.4	55.4
Kentucky Fried Chicken	325	2397 (42.0)	958 (16.1)	2504 (38.4)	2.2	16.9	24.0	56.9
Popeye's	260	2497 (84.8)	1050 (31.5)	2418 (52.0)	1.2	11.5	33.8	53.5
Pizza chain	242	1734 (214.5)	793 (120.2)	2317 (77.1)	0.8	52.1	27.3	19.8
Domino's	29	2465 (488.6)	1550 (201.4)	1545 (105.6)	6.9	37.9	6.9	48.3
Papa John's	191	1561 (184.9)	652 (80.7)	2443 (22.6)	0.0	56.5	28.8	14.7
Pizza Hut	22	2272 (327.4)	1017 (127.7)	2233 (126.0)	0.0	31.8	40.9	27.3
Tex-Mex chain	95	1849 (94.5)	909 (55.6)	2093 (31.6)	2.1	34.7	38.9	24.2
Taco Bell	95	1849 (94.5)	909 (55.6)	2093 (31.6)	2.1	34.7	38.9	24.2
Colocated chains <sup>b</sup>	425	1912 (89.8)	897 (28.2)	2156 (47.5)	5.6	34.1	32.5	27.8

<sup>a</sup>Maximum limits include the following: 600 mg, maximum sodium limit for meals and main dishes to use the claim "healthy," as defined by the Food and Drug Administration; 1500 mg, maximum daily sodium intake recommended for hypertensive, black, and middle-aged and older adults; and 2300 mg, maximum daily sodium intake recommended for adults who do not fall into one of the groups that is covered by the 1500 mg/d recommendation.

<sup>b</sup>Colocated chains include locations where 2 or more chains (ie, Burger King, Kentucky Fried Chicken, Pizza Hut) operated at the same address and storefront.

Important strengths of this study include the use of receipts of meals purchased rather than reliance on patron self-report and the large sample of patrons from randomly selected locations. Limitations include a lack of patron demographic data. In addition, participants were not asked about salt added at the table, potentially underestimating sodium content per meal. A meal as defined in this study may not include purchases that a patron considers a meal, such as a large order of French fries, and may classify as a meal for some purchases that the patron viewed as a snack. Finally, the food establishments studied may not be representative of all fast food restaurants.

Fast food is not only a high-calorie but also a high-sodium food. Its widespread consumption contributes to current high levels of daily sodium intake in the United States, higher blood pressure, and the resulting burden of cardiovascular disease. Consequently, reducing sodium levels in fast food meals is a public health priority. Our findings support the need for the fast food industry to focus on reducing sodium levels across product lines. Government, public health, and industry involvement to accelerate food reformulation will reduce blood pressure and save lives.

Christine M. Johnson, MBA  
Sonia Y. Angell, MD, MPH  
Ashley Lederer, MS, RD  
Tamara Dumanovsky, PhD  
Christina Huang, MPH  
Mary T. Bassett, MD, MPH  
Lynn D. Silver, MD, MPH

**Author Affiliations:** New York City Department of Health and Mental Hygiene, New York, New York.

**Correspondence:** Ms Johnson, Cardiovascular Disease Prevention and Control Program, NYC Department of Health and Mental Hygiene, 2 Lafayette St, 14th Floor, CN-46, New York, NY 10007 (cjohnso8@health.nyc.gov).

**Author Contributions:** Ms Johnson had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Johnson, Angell, Dumanovsky, Bassett, and Silver. *Acquisition of data:* Dumanovsky and Silver. *Analysis and interpretation of data:* Johnson, Angell, Lederer, Dumanovsky, Huang, Bassett, and Silver. *Drafting of the manuscript:* Johnson, Angell, and Lederer. *Critical revision of the manuscript for important intellectual content:* Johnson, Angell, Lederer, Dumanovsky, Huang, Bassett, and Silver. *Statistical analysis:* Dumanovsky and Huang. *Obtained funding:* Silver. *Administrative, technical, and material support:* Lederer, Huang, and Silver. *Study supervision:* Johnson, Angell, Bassett, and Silver.

**Financial Disclosure:** Ms Johnson formerly owned 200 shares of Yum! Brands Inc.

**Funding/Support:** This study was fully funded by NYC tax levy dollars.

1. Lloyd-Jones D, Adams R, Carnethon M, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics—2009 Update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation*. 2009;119(3):e21-e181.
2. Institute of Medicine. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride and Sulfate*. Washington, DC: National Academy Press; 2004.
3. US Department of Health and Human Services and U.S. Department of Agriculture. *Dietary Guidelines for Americans*, 2005. 6th ed. Washington, DC: Government Printing Office; 2005.
4. Centers for Disease Control and Prevention (CDC). Application of lower sodium intake recommendations to adults—United States, 1999–2006. *MMWR Morb Mortal Wkly Rep*. 2009;58(11):281–283.

5. Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. *Annu Rev Nutr.* 2004;24(1):401-431.
6. Mattes RD, Donnelly D. Relative contributions of dietary sodium sources. *J Am Coll Nutr.* 1991;10(4):383-393.
7. Dickinson BD, Havas S; Council on Science and Public Health, American Medical Association. Reducing the population burden of cardiovascular disease by reducing sodium intake: a report of the Council on Science and Public Health. *Arch Intern Med.* 2007;167(14):1460-1468.
8. Bibbins-Domingo K, Chertow GM, Coxson PG, et al. Projected effect of dietary salt reductions on future cardiovascular disease. *N Engl J Med.* 2010;362(7):590-599.
9. Bassett MT, Dumanovsky T, Huang C, et al. Purchasing behavior and calorie information at fast-food chains in New York City, 2007. *Am J Public Health.* 2008;98(8):1457-1459.
10. Keystone Forum on Away-From-Home Foods. *Opportunities for Preventing Weight Gain and Obesity.* Washington, DC: Keystone Center; 2006.
11. Food Standards Agency. Summary table of commitments to salt reduction. <http://www.food.gov.uk/multimedia/spreadsheets/saltcommitmentsum.xls>. Accessed December 08, 2009.

## Comparative Analysis of Different Approaches to Report Diagnostic Accuracy

The accuracy of a diagnostic test is traditionally reported in terms of sensitivity and specificity and predictive values in scientific articles, systematic reviews, and test inserts. Physicians tend, however, to confuse sensitivity and specificity, which are independent of the prevalence, with positive and negative predictive values, which are dependent on the prevalence.<sup>1</sup>

An alternative way of expressing diagnostic accuracy is the likelihood ratio (LR).<sup>2</sup> Likelihood ratios offer the advantage that they are not dependent on the prevalence of the disease, in contrast to positive and negative predictive values, and can be used for nondichotomous test results.<sup>3-5</sup> Steurer and coworkers<sup>1</sup> found that reporting diagnostic accuracy as LRs expressed in nontechnical language is more intelligible to clinicians, although a subsequent randomized trial by the same group found no difference in posttest probability estimates between LRs in nontechnical language and sensitivity and specificity.<sup>6</sup>

Most practicing physicians do not use the Bayesian approach to calculate posttest probability because they consider it impractical and difficult to calculate.<sup>7</sup> The use of a graphic representation of the posttest probability as a function of the pretest probability could overcome these problems. This approach has, however, not been studied. While such approach is ill suited for printed laboratory reports, the current advances in information technology allow laboratories to provide this graphic representation “one mouse click away” to clinicians when results are checked electronically.

**Methods.** We developed a 3-item questionnaire. Each question asked the respondent to estimate the posttest probability and included a pretest probability in the form of a prevalence and results of diagnostic accuracy. Depending on the question, the diagnostic accuracy was presented as sensitivity and specificity, LR in nontechnical terms, or graphically. The questionnaire, in English translation, is shown in **Figure 1**.

The questionnaire was distributed to 117 general practitioners and 55 specialists in internal medicine, including trainees, at 2 separate conferences on continuing medical education. The program did not include any specific

**Question 1:** A diagnostic test has a sensitivity of 95% and specificity of 90%. The prevalence of the disorder is 2.5%. What is the probability that a person with a positive (abnormal) result has the disease?

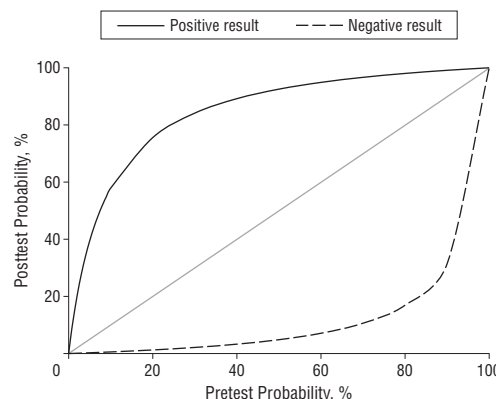
- |                                         |          |
|-----------------------------------------|----------|
| <input type="radio"/> Less than 10%     | 7 (6%)   |
| <input type="radio"/> Approximately 20% | 8 (7%)   |
| <input type="radio"/> Approximately 50% | 5 (4%)   |
| <input type="radio"/> Approximately 90% | 85 (69%) |
| <input type="radio"/> I don't know      | 18 (15%) |

**Question 2:** The prevalence of a disorder is 2.5%. A positive result is observed approximately 10 times more frequently in people with the disease than in people without the disease. What is the probability that a person with a positive (abnormal) result has the disease?

- |                                         |          |
|-----------------------------------------|----------|
| <input type="radio"/> Less than 10%     | 10 (8%)  |
| <input type="radio"/> Approximately 20% | 33 (27%) |
| <input type="radio"/> Approximately 50% | 10 (8%)  |
| <input type="radio"/> Approximately 90% | 43 (35%) |
| <input type="radio"/> I don't know      | 27 (22%) |

**Question 3:** The prevalence of a disorder is 20%. The test characteristics of the test are shown in the graph below. What is the probability that a person with a positive (abnormal) result has the disease?

- |                                         |          |
|-----------------------------------------|----------|
| <input type="radio"/> Less than 40%     | 2 (2%)   |
| <input type="radio"/> Approximately 50% | 11 (9%)  |
| <input type="radio"/> Approximately 80% | 61 (50%) |
| <input type="radio"/> More than 90%     | 9 (7%)   |
| <input type="radio"/> I don't know      | 40 (33%) |



**Figure 1.** The questionnaire and the answers by clinicians (given as number and percentage of responses) to questions 1, 2, and 3.

information regarding the performance of diagnostic tests. The chairman asked participants to complete the questionnaire during the small breaks between the speakers. The questionnaires were collected immediately after the last speaker of the session.

Of the 172 eligible clinicians, 123 filled in the questionnaire (response rate, 72%). The clinicians answering the questions had on average more than 25 years of experience as a physician and had on average more than 40 patient contact hours per week. The correct answer to question 1 was “approximately 20%” (19.6% exactly). The second question described the same test as the first question, but the diagnostic accuracy information was described as an LR in nontechnical language (Figure 1). Since the LR equals sensitivity/(1 – specificity), the LR for the first test was 9.5. The correct answer for question 2 was also “approximately 20%” (20.4% exactly).

The third question provided a graphic representation of the posttest probability as a function of the pretest probability. The test depicted was relatively similar to the tests in the 2 previous questions, with an LR of 12.4 for a positive result. Given the higher prevalence of 20%, the correct answer was “approximately 80%” (75.5%