A Prospective Study of Response Error in Food History Questionnaires: Implications for Foodborne Outbreak Investigation

JONATHAN M. MANN, MD, MPH

Abstract: To explore the problem of response error in food history data, a prospective study examined the validity of food questionnaire data obtained five days after the study meal. Unobtrusive observation of 64 persons selecting two different foods at a buffet-style luncheon were compared with subsequent histories of food consumption. The predictive value of a positive response was 0.73 for one food and 0.82 for the second food. The response error measures obtained were then applied to data from a published foodborne outbreak to illustrate the impact of predictive value positive and predictive value negative levels on the significance of a food-illness association. Public health workers engaged in food questionnaire administration and analysis must consider response error and should explore methods of reducing this problem through attention to both interviewer-respondent interaction and questionnaire design. (*Am J Public Health* 1981;71:1362–1366.)

The food history questionnaire is an essential part of a thorough foodborne disease outbreak investigation.[1,2] Usually administered days to weeks after the suspect meal was served, the questionnaire gathers information on specific foods reported to have been consumed by ill and well persons present at the meal. The proportion of ill persons said to have eaten each food item is compared with the proportion of well persons reporting consumption of that food; the food item or items with the largest difference between ill and well proportions is then suspected as the vehicle of disease transmission.[1,2] Further statistical analysis is often performed to determine which food items are significantly associated with illness.[2,3]

When laboratory examination of foods served at implicated meals is inadequate or impossible, the analysis of food questionnaires may represent the only data with which to link a food to illness. Laboratory confirmation of epidemiologically implicated food was obtained in only 65 (60 per cent) of 108 foodborne outbreaks of known bacterial etiology reported to the Centers for Disease Control (CDC) in 1978.[4] In addition, 30 to 60 per cent of foodborne outbreaks reported to CDC from 1973–1975 were of undetermined etiology; nevertheless, a specific food or foods were listed as the responsible vehicle in 46 per cent of these outbreaks of unknown etiology.[4]

Given the fallibility of memory and the importance of food questionnaire data under these circumstances, an effort to assess the validity of food histories seemed relevant. A prospective study was designed to determine the validity of food questionnaire data as obtained in typical foodborne outbreak investigations. Results of this study were then applied to a published foodborne outbreak report to explore their impact on reported food-to-illness associations.

Materials and Methods

A pot-luck luncheon held by and for staff of the Health Services Division of the New Mexico Health and Environment Department on March 27, 1981 was selected for study. Two staff public health nurses acted as observers. Each chose one food item, the only dish of its kind, to be served at the buffet-style meal for selective observation. The nurses positioned themselves so that they could unobtrusively observe and note the name of every person who took any of the two study foods onto his or her plate.

The following Monday (three days after the event), the author, who was not present at the luncheon, selected 10 distinctive food items from the 17 foods listed on the luncheon sign-up sheet, each of which fulfilled the criteria for food selection as outlined above. The nurses verified the presence of both study foods among the 10 selected but did not reveal the identity of the items.

Five days after the luncheon, the author and an assistant with epidemiologic experience administered a typical food history questionnaire listing the 10 food items to luncheon attendees. The age and sex of participants were obtained along with their responses to specific and separate questions about their consumption of each of the 10 food items.

All interviews were conducted between 8am and 3pm on the fifth day after the luncheon. The questionnaire data were then compared with the nurses' lists. Two by two tables were constructed for the two observed foods, comparing the

Address reprint requests to Jonathan M. Mann, MD, MPH, Assistant Director, Health Services Division, New Mexico Health and Environment Department, P.O. Box 968, Santa Fe, NM 87503.
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TABLE 1—Comparison of Observation of Serving Self Potato Salad and Subsequent History of Potato Salad Consumption, 57 Persons, 1981

Food History Data	Observation Data: Potato Salad Put Onto Plate	Observation Data: Potato Salad Not Put Onto Plate	Total
Ate potato salad	22	8	30
Did not eat potato salad	3	24	27
TOTAL	25	32	57

Sensitivity of history of eating potato salad = 22/25, or 0.88.
Specificity of history of not eating potato salad = 24/32, or 0.75.
Predictive value of a positive history of eating potato salad = 22/30, or 0.73.
Predictive value of a negative history of eating potato salad = 24/27, or 0.89.

observation of whether food was taken onto the person's plate with the interview history of food consumption. The sensitivity, specificity, and predictive values of a positive and a negative food history response were calculated.[5]

Results

The two items observed by the nurses were potato salad and quiche. Sixty-four persons attended the luncheon and 57 (89 per cent) were interviewed.* Forty-two (74 per cent) of the 57 interviews were conducted in person and the remainder were taken over the telephone. Results for the two food items are shown in Tables 1 and 2. Accuracy of response, defined as concordance of observation data and food history, was not significantly associated with age or sex of the participants.

Unknown to the author, a food item listed on the sign-up sheet and included as one of the 10 foods in the questionnaire, a green chili stew, was not actually served at the luncheon. Eight persons (14 per cent) reported eating this distinctive food at the luncheon.

*Four persons were out-of-state, one had an illness in the family, one had left employment with the Division, and one person refused to participate in the study.

The luncheon potato salad results were then applied to a published report of a C_2 salmonella outbreak in which food history data implicated potato salad as the vehicle of transmission but in which no corroborating laboratory data for the suspected food was obtained.[6] The food history data were derived from a survey conducted two to three weeks after the suspected meal was served and demonstrated a significant association between potato salad and illness. The published data, converted into a 2 × 2 table and subjected to Chi-square calculations, are shown in Table 3. Re-analysis of this food history data according to parameters obtained in the luncheon study is shown in Figure 1. The new 2 × 2 Table derived from Figure 1 (shown in Table 4) fails to show a significant association between potato salad and illness.

Discussion

The pot-luck luncheon study was prospective, unobtrusive, and designed to protect against subject or interviewer bias related to knowledge of study food items. Nevertheless, it has several limitations. First, since an outbreak of illness did not occur, neither illness nor anxiety impacted on the participants' food recall. An outbreak's effect on the validity of food histories is difficult to predict, as heightened attention and an emotional climate might either improve or impair

TABLE 2—Comparison of Observation of Serving Self Quiche and Subsequent History of Quiche Consumption, 57 Persons, 1981

Food History Data	Observation Data: Quiche Put Onto Plate	Observation Data: Quiche Not Put Onto Plate	Total
Ate quiche	14	3	17
Did not eat quiche	2	38	40
TOTAL	16	41	57

Sensitivity of history of eating quiche = 14/16, or 0.88.
Specificity of history of not eating quiche = 38/41, or 0.93.
Predictive value of a positive history of eating quiche = 14/17, or 0.82.
Predictive value of a negative history of eating quiche = 38/40, or 0.95.

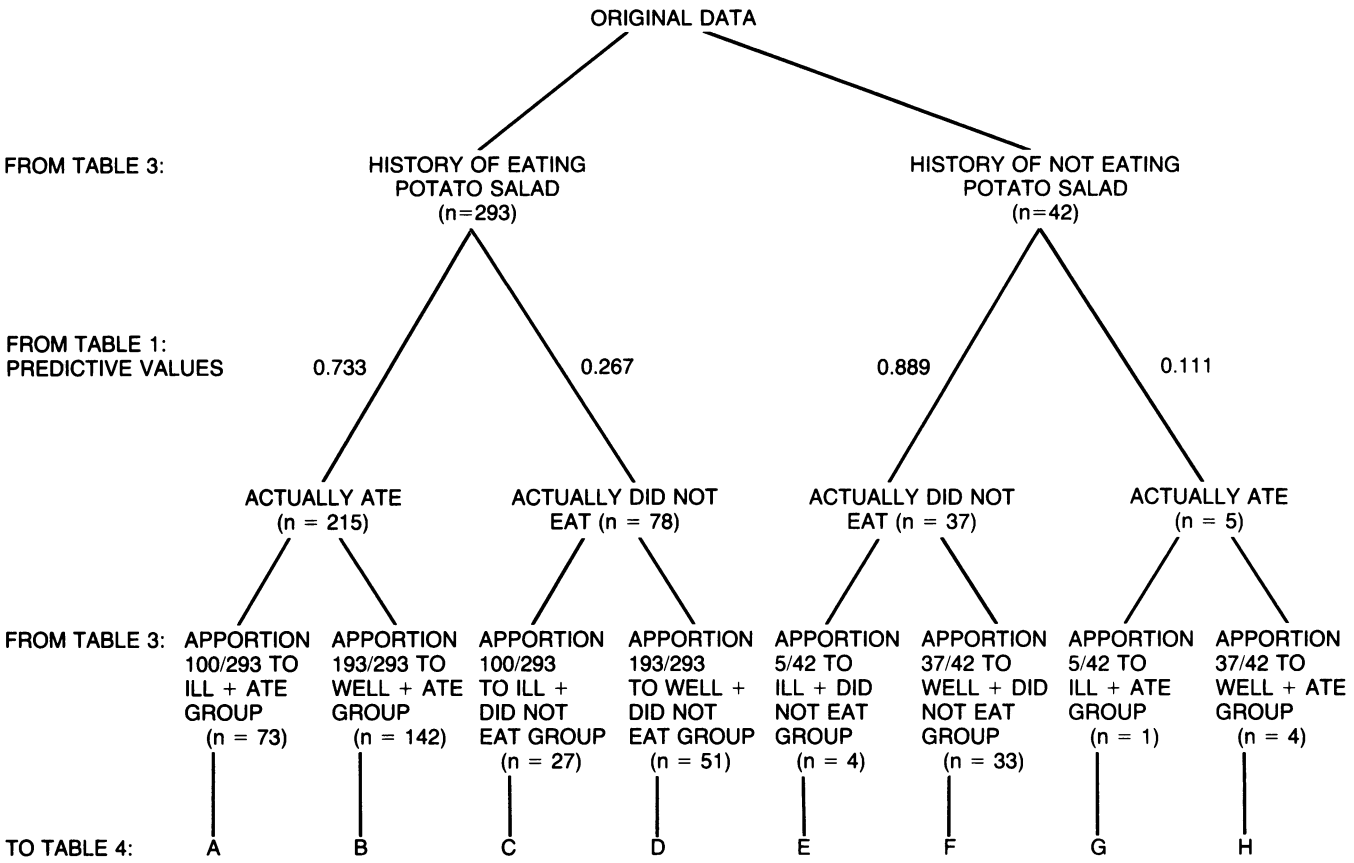

FIGURE 1—Re-Analysis of Food History Data from Salmonella C2 Outbreak According to Parameters Derived in Pot-luck Luncheon Study

accurate recall. Second, the observers could not determine who actually consumed the study foods but only documented the taking of food onto plates. Questions about sharing of foods were not asked. The probability that an adult would take food from a co-worker's plate was assumed to be low (based on the author's observations during previous pot-luck meals attended by this group), and was considered much less likely than the possibility of a person not eating at least some amount of a food known to have been taken onto his or her plate in a buffet-luncheon setting. For this reason, along with the unanticipated and corroborative measure of overreporting about consumption of an absent food item, the predictive value of a positive response was considered the more valid measure derived from this study.

Third, the generalizability of results from this study may be affected by the study population (about one-half health professionals and one-half secretarial and clerical staff), the total number of food choices available at this luncheon (many more food choices compared with a typical sit-down banquet meal), details of the food service setting, and the particular foods chosen for study. For example, higher predictive values for quiche compared with potato salad in this study may be related to its limited supply, as only enough for 18 persons was prepared. Many questionnaire

TABLE 3—History of Consumption of Potato Salad and Illness Derived from Salmonella C_2 Foodborne Outbreak, 1974[6]

	Food Questionnaire Data		
Health Status	Ate Potato Salad	Did Not Eat Potato Salad	Total
Ill	100	5	105
Well	193	37	230
TOTAL	293	42	335

X^2 with 1 df, Yates Correction; $X^2 = 7.43$, $p < 0.01$

TABLE 4—Re-Analysis of Food History Data from Salmonella C_2 Outbreak According to Calculations Derived from Figure 1

	Actual History of Eating		
Health Status	Ate Potato Salad	Did Not Eat Potato Salad	Total
Ill	A + G = 74	C + E = 31	105
Well	B + H = 146	D + F = 84	230
TOTAL	220	115	335

X^2 with 1 df, Yates Correction; $X^2 = 1.27$, $p > 0.20$

respondents easily recalled their disappointment that quiche was unavailable by the time they reached the buffet tables.

Fourth, observer error, leading to mistakes in the lists of persons taking study foods onto their plates may have occurred, but is unlikely since food lines were orderly and slow-moving and participants were known to the nurse observers. Finally, choosing to interview participants five days after the meal, although arbitrary, was selected as an average latency between the implicated meal and administration of a food history questionnaire as part of the outbreak investigation. This period may be too long for some outbreaks (staphylococcal or heavy metal poisoning) yet too short for others (typhoid, hepatitis A). The latency also incorporates the incubation period of the particular illness, time until the outbreak is recognized and reported, and investigative response time, which may vary considerably even among outbreaks caused by the same etiologic agent.

Prior studies of the validity of food consumption information have generally focused on usual or customary dietary patterns rather than meal or date-specific histories, and have only infrequently sought external confirmation of interview data.[7] One exception, a study of food history validity, compared specific food item recall for foods eaten the previous day with diet diary information among 50 adult Japanese-American males.[8] For six food items actually consumed by 10 or more study participants, the predictive value of a positive response ranged from 0.98 (rice) to 0.64 (chicken) with a median value of 0.75. The predictive value of a negative response ranged from 1.0 (rice) to 0.76 (beef), with a median value of 0.86. While that study's design differed considerably from our pot-luck luncheon study, the finding of both overreporting and underreporting of a similar magnitude helps to strengthen the reasonableness of the luncheon study data.

The luncheon study results serve as a reminder that food history questionnaire data, like other questionnaire-based survey information, are subject to response error.[2] Response error considers the interviewer, the respondent and their interaction in the interview setting, with attention to the role of interviewer behavior on response and the complexity of memory and information retrieval processes.[9]

Given the inherent problem of response error, strategies aimed at reducing this error derived from survey methodology research may be relevant to foodborne outbreak investigations. For example, use of standardized reinforcement, attention to standardized instructions, or use of a commitment strategy (respondent signs statement or otherwise certifies willingness to provide the most accurate and complete answers possible) should be considered. Efforts to improve information retrieval could involve returning the completed questionnaire to the respondent for review. This approach permits a person to reconsider answers after their full attention has been focused on the meal. An appreciation for the complexity of information storage and retrieval should extend to the design of food history questionnaires, as "standard questions may not represent the most adequate stimuli to activate respondent recall because they may ignore the way in which information is organized in memory."[9]

Several alternative questionnaire structures might include: bringing the respondent through the meal in a sequential, course-by-course manner; focusing attention onto the appearance or organization of the person's plate; assisting memory by reconstructing the physical setting of a buffet table with a model or drawings; or linking food recall to other cues or events within the meal (appearance of servers at a buffet table or timing of a luncheon speech). These approaches may be better adapted to fostering accurate recall than current efforts to elicit response to a simple listing of individual food items. In addition, routine inclusion of a food not served at the implicated meal may provide an internal measure of overreporting.

Food history questionnaires are only one component of a complete foodborne outbreak investigation.[1,2] However, despite mention of the difficulties inherent in the interview process in manuals of foodborne outbreak investigation,[1,2] the data collected in food history questionnaires may tend to be accepted as intrinsically valid for purposes of statistical analysis. The investgiator's focus may be directed more toward the statistical robustness of the association than to sources of response error and their impact on the association.

In addition to efforts to reduce response error, if corroborating evidence of the vehicle of disease transmission is lacking, food history data could be subjected to a series of assumptions about response error and re-analyzed. This process, as outlined in Figure 1, could gauge the stability of the food-illness association within specified and acceptable boundaries of response error. Finally, this study reemphasizes that the questionnaire-based linkage of food and illness

should be interpreted cautiously in the absence of confirmatory laboratory data.

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