EFFECTS OF PROCEDURAL DIFFERENCES IN THE NATIONWIDE FOOD CONSUMPTION SURVEY

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Each Nationwide Food Consumption Survey conducted by the U.S. Department of Agriculture provides a "snapshot" of the dietary status of the U.S. population at a particular point in time, but trends in food and nutrient intake over time are also of interest. A "tension" exists between maintaining the status quo for the sake of comparability versus making changes to improve the quality of the estimates (Kaprzyk 1989).

PURPOSE

The 1988 Bridging Study was conducted to facilitate the comparison of results of the 1977-78 Nationwide Food Consumption Survey (NFCS) with results of the 1987-88 NFCS. Its purpose was to determine whether or not the differences between procedures used in 1977-78 and those used in 1987-88 could result in differences in estimated food and nutrient intakes based on 1-day dietary recalls.

The same contractor conducted the NFCS both in 1977-78 and in 1987-88 under contract with USDA. Both surveys used an in-home, interviewer-administered 24-hour recall followed by a self-administered 2-day record to collect dietary intake information. Thus, the data collection methods were essentially the same (Guenther and Pao 1987). Between the two surveys, however, improvements were made in interview and coding procedures and in the nutrient data base.

A series of probing questions was added to the interview to assist respondents in recalling food items that were thought to be often forgotten; and the Food Instruction Booklet, which is used during the interview to help respondents report foods, was expanded from 4 to 18 pages to capture more detailed food descriptions and more accurate quantitities. Other than that, the basic format, flow, and content of the 1977 and 1987 questionnaires were very similar.

The interviewers mailed the completed schedules to a central office where they were coded. In 1977, coders searched the food code book manually; in 1987, they used a partially automated coding system.

The food code manual was updated by adding codes for new foods; and the weight conversion factors, which are used to convert amounts of food reported by respondents in household measures to their equivalent weight in grams, were reviewed and revised as needed. For example, if a respondent reports drinking 1 cup of milk, it is converted to 245 grams.

After coding, the records were linked to a nutrient data base to calculate nutrient intakes. Between the two surveys, USDA updated the nutrient data base to reflect changes in the nutrient composition of foods and improvements in the quality of the data (Perloff 1989). Examples of real changes in food products were the development of varieties of carrots with higher vitamin A content and closer trimming of fat from cuts of meat at the retail level. Most of the changes in the nutrient data base, however, were a result of data improvements, such as more food samples and improved analytical techiques.

The Bridging Study was designed to determine whether the differences between results of the 1977-78 and the 1987-88 NFCS will be affected by these improvements. A detailed hypothesis testing plan was developed to answer specific research questions (Guenther and Perloff 1990). The questions included: Do the changes that were made result in a difference in the estimated mean intakes of food energy, fat, and other nutrients or in the mean intakes of foods from 10 major food groups? Then, were any such differences caused by the changes in interviewing procedures, the food coding procedures, the weight conversion factors, or the nutrient data base?

THREATS TO VALIDITY

Many types of errors can threaten the validity or accuracy of survey data in general (Groves 1989). Errors of nonobservation can be caused by lack of coverage of the target population. For example, a survey of all individuals in the U.S. may be desired, but homeless people may not be included. Nonobservation errors may also be sampling errors caused by the disproportionate selection of members of the target population without appropriate weighting. They may be caused by nonresponse; people selected may not be reached or may refuse to participate. Observational errors may be introduced by the interviewer, by the respondent, and by the data collection instrument and its mode of administration. Additional errors may be introduced during coding and further processing of the data.

Several types of respondent error can result in differences between actual and reported behavior (Sudman and Bradburn 1982). One is memory; respondents may simply forget items or remember them incorrectly. A second is motivation; respondents may not answer truthfully because they want to give a socially desirable answer. For example, recent increases in public awareness of the potential risks of a high-fat diet could contribute to the reporting of more desirable, low-fat diets. Another type is comprehension; respondents may not understand the question or may answer in their own terms. A fourth is knowledge; respondents may simply not know but give an answer anyway.

Memory is considered to be the most important problem with nonthreating survey questions, especially with low-salience topics that occur frequently (Dwyer, Krall, and Coleman 1987, Sudman and Bradburn 1982). Food intake is a low-salience topic. Eating is a routine activity compared with more important events that some other surveys address such as hospitalization or being the victim of a crime.

DESIGN AND PROCEDURES

The 1988 Bridging Study duplicated as far as possible the procedures used in collecting, coding, and processing dietary intake data in the NFCS 1977-78 and the NFCS 1987-88. USDA staff reviewed the 1977-78 food code manual and food coding guidelines and updated the 1977 manual by adding new foods wherever possible. A small, informal pilot test was conducted before the interviewer training sessions.

The experiment was designed using a split sample. Complete interviews were obtained from 697 women living in households in the greater Philadelphia area. Philadelphia was chosen because a homogeneous sample was needed and because that is where the contractor was located. Seventy-two area segments were randomly selected, each having at least 150 housing units. Ten housing units were selected in each segment and randomly assigned to one of two treatment groups, called A and B. This served to control as many external variables as possible. The two treatment groups were very similar in all 19 personal and household characteristics identified. Differences in means and proportions were not greater than 2 percentage points, except for household income, which differed by only 5%.

Two separate groups of interviewers were trained for each of the two treatment conditions. They contacted each household in the sample and determined whether it had a woman aged 20 to 49 years who was willing to participate. Then they asked questions about individual and household characteristics and collected information from the respondent about all the foods she had eaten during the previous day. The Group A interviewers used the 1987-88 individual intake questionnaire; and Group B used the 1977-78 questionnaire. Like the interviewers, the reviewers, coders, and other study personnel were allocated to one of two separate groups, working with either 1977-78 or 1987-88 data collection, coding, and processing activities.

The Group A questionnaires were coded only under 1987-88 procedures; but the Group B questionnaires were copied after review and coded twice by different teams of coders. One team used the 1977-78 procedures, and the other used the 1987-88 procedures.

The 1977-78 coding was carried out by a team of three coders who had had NFCS 1977-78 coding experience but had not coded food records since that time. The 1987-88 coding procedures were carried out by two experienced NFCS 1987-88 coders, so there was an equal level of experience among all the coders.

The USDA staff who answered the requests from the contractor for coding assistance under the 1987-88 procedures were the same staff who were working on the individual intake portion of the NFCS 1987-88 in progress at the time. The 1977-78 team at USDA made every effort to answer requests as they would have during the NFCS 1977-78. The 1977 and 1987 coding of the Bridging Study data were carefully kept separate to avoid any contamination by either the contractor or USDA.

The reported amount of each food item was converted into its gram-weight equivalent. Total daily intakes were calculated for food energy, fat, protein, carbohydrate, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, and vitamins B-6, B-12, and C. These are all of the nutrients reported in the NFCS 1977-78.

ANALYSIS

Creation of Variables

The contractor produced three of the data sets: one for Group A individuals interviewed and coded under 1987-88 procedures, which became data set A; one for Group B individuals interviewed and coded under all 1977-78 procedures, which became data set B4; and one for Group B individuals interviewed under 1977-78 procedures but coded under 1987 procedures, which became data set B1.

Two additional data sets were prepared later at USDA. Data set B3 consisted of food and nutrient intakes for Group B women, calculated using the 1977-78 food codes and weight conversion factors but with the 1987-88 nutrient data base. For this purpose, the 1977 food codes were linked to the 1987-88 codes having matching, or most similar, descriptions. B2 consisted of intakes for Group B women calculated using the 1977-78 food codes with the 1987-88 weight conversion factors and the 1987-88 nutrient data base. Thus, intakes for Group B were calculated four different ways. The origins of the five data sets are illustrated in Figure 1. The various differing procedures and their possible effects on food and nutrient intake results were analyzed using SPSS-X, version 3.0 (SPSS, Inc. 1988).

Level of Significance

When the study was in the planning stage, the proposal evaluation panel had agreed that the most important test would be the one for differences in fat intake because of its major public health importance. Also, a greater emphasis was placed on some fat-related probes in the NFCS 1987-88 than in 1977-78. It had been suggested that this might result in lower reported fat intakes (Committee on Diet and Health). A meaningful detectable difference was thought to be 2.0 grams of fat per 1,000 kilocalories of energy intake. That is, we wanted to be able to detect a difference if the mean fat intake of Group B, calculated under all 1977 procedures, was at least 2.0 grams per 1,000 kilocalories higher than the mean value for Group A.

Our estimate of fat intake per 1,000 calories in spring of 1977 had been 45.3 grams for women age 19 to 50 years. In the spring of 1985, it had been 40.7 grams (U.S. Dept. of Agriculture 1985). We wanted to be able to detect a difference of half that size in the Bridging Study. Using estimated population variances, we determined that a sample size of 350 women in each group was required if the power of the test was to be at least .80 at a significance level of .10 (Shavelson 1981).

Once the actual sample variances from the Bridging Study were known, we calculated the power of this test with alpha set at .10; it was .85. If alpha had been set at .05, a more conventional level, the power would have been only .75. Considering the relative risks of rejecting the null hypothesis when it was true (a Type I error), and of not rejecting it when it was false (a Type II error), the alpha of .10 was retained for use throughout the study. Usually, researchers have to be more concerned about a Type I error, but we had to be more concerned about not detecting effects of procedural differences that did, in fact, exist, which would have been a Type II error.

RESULTS

Results obtained using the "pure" 1987 and the "pure" 1977 procedures are shown below in Table 1 under data sets A and B4, respectively. The effects of changes in interview procedures are represented by the differences between data sets A and B1, the changes in food coding procedures by B1 and B2, and the changes in conversion from reported units of measure to gram weights by B2 and B3, and the changes in the nutrient data base (both real and artifactual) by B3 and B4.

A two-sample, multivariate T-test was used to determine that the nutrient intakes by the two groups of women (A and B4) were significantly different when the nutrients were considered jointly (Norušis 1988). The F test results for each nutrient were then examined. Mean intakes of food energy and fat by women in the two groups, A and B4, were virtually identical. The change in the fat content of meat because of closer trimming at the retail level, mentioned above as an example of a real change in food, was not reflected in a significant overall difference in fat intake between the two groups of women. The decrease was offset to some extent by another change in the nutrient data base--an increase in the fat content of grain mixtures, such as pizza and macaroni and cheese. The effect of the differences in weight conversions (B2 versus B3) also offset the data base difference (B3 versus B4).

Nutrient intakes were significantly different between the two groups of women at the .10 level only for magnesium, thiamin, and iron (A versus B4). Differences related to interview procedures (A versus B1) were not significant for any of the three nutrients, according to univariate t-tests.

Repeated measures analysis of variance was used for each of the three nutrients to determine that there was a significant difference among the results obtained from Group B computed in the four different ways. Three univariate, paired t-tests were then used to determine which pairs of results differed statistically. The differences attributable to food coding (B1 versus B2) were not significant for any of the three nutrients. However, the weight conversion differences (B2 versus B3) were small but significant for all three nutrients. They were probably caused by focusing more on descriptions of amounts as "small," "medium," and "large" in 1977-78; while more emphasis was placed on the use of dimensions and cubic inches in 1987-88.

Differences resulting from changes in the nutrient data base (B3 versus B4) were statistically significant for magnesium and thiamin but not for iron. The difference between the 212 mg (B3) and 233 mg (B4) of magnesium was caused primarily by an artifactual decrease in the magnesium value for coffee. The decrease reflected more recent, but still limited, analytical data. While coffee is not usually considered a nutrient source, it does contain small to moderate amounts of a few nutrients, including magnesium. Because coffee is so frequently consumed, it can make a significant contribution to magnesium intake, especially among women (U.S. Dept. of Agriculture 1984).

Thiamin is widely distributed in foods, and many items in the data base had small changes in thiamin content. Meat and grain products contributed most to the increase. While the changes reflect a combination of real food product changes and data improvements, they are mostly real.
Although the difference in iron values attributable to changes in the nutrient data base was not statistically significant, major changes had taken place. Iron values in beef and pork decreased because of improvements in the data. However, these decreases were more than offset by the real increases in grain products resulting from a change in enrichment standards and increased fortification. The 1977-78 nutrient data base will be revised to incorporate the improved meat values so that valid 1977-1987 comparisons can be made because the sources of iron in the diet are important and because iron is a public health concern.

made between the NFCS 1977-78 and the NFCS 1987-88 in interview procedures, including probes, and in coding procedures had little effect on estimated intakes of all nutrients; they should be of little concern. The second is that the weight conversion and nutrient data changes influenced results for some nutrients but not for others. The effects of these changes should be considered when comparing results of the NFCS 1987-88 with the NFCS 1977-78 for iron, magnesium, and vitamin B-12.

The NFCS generally conformed to a set of guidelines that were suggested by a panel, convened by the Life Sciences Research Office, for appropriate use of dietary data to determine differences over time (Anderson 1988). The Bridging Study addressed two of the guidelines in particular. The methods used in the two surveys were generally equivalent, as one guideline specifies, although procedures differed somewhat in detail. The nutrient data bases were created to represent the composition of foods eaten at each point in time, as specified by another guideline. The NFCS 1977-78 and the NFCS 1987-88 met the remaining guidelines: the conceptual basis for the variables is constant between the two surveys; the time interval between the two surveys is long; and the sampling procedures are equivalent. The last guideline also implies that the survey results should adequately represent the target populations at the two points in time; that issue will be investigated by USDA. We will consider the results of that study, together with the results of the Bridging Study, when assessing the changes in dietary intakes revealed by the results of the NFCS 1977-78 and the NFCS 1987-88.

Large differences resulting from changes in the nutrient data base were also seen for vitamins A and B-12. Vitamin A is highly concentrated in deep-yellow and dark-green vegetables. The difference in vitamin A intake was caused primarily by the increase in vitamin A content of carrots and sweetpotatoes--a real change in these foods. Women in Group A happened to have smaller intakes of foods high in vitamin A, especially carrots, than women in Group B. This chance difference in actual food intakes (A versus B1) was in the direction that offset the difference in the nutrient data bases (B3 versus B4).

The difference in vitamin B-12 intakes caused by the two different data bases (B3 versus B4) was primarily the result of higher vitamin B-12 values in 1987 for meat and fish, which are good sources of this nutrient. The difference in vitamin B-12 intakes between A and B4 was not statistically significant, probably because of the large interindividual variation in 1-day intakes of this nutrient. This last result was not surprising because the sample size was set to detect differences in fat and not in vitamin B-12.

To determine if food intakes differed significantly between the two groups of women, all foods eaten were categorized into the 10 major food groups shown in Table 2. Multivariate results indicated that the difference between A and B4 was not statistically significant across the 10 intake levels.

CONCLUSIONS

Two main conclusions have been drawn from the Bridging Study. The first is that the changes and improvements

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Figure 1. Study Design

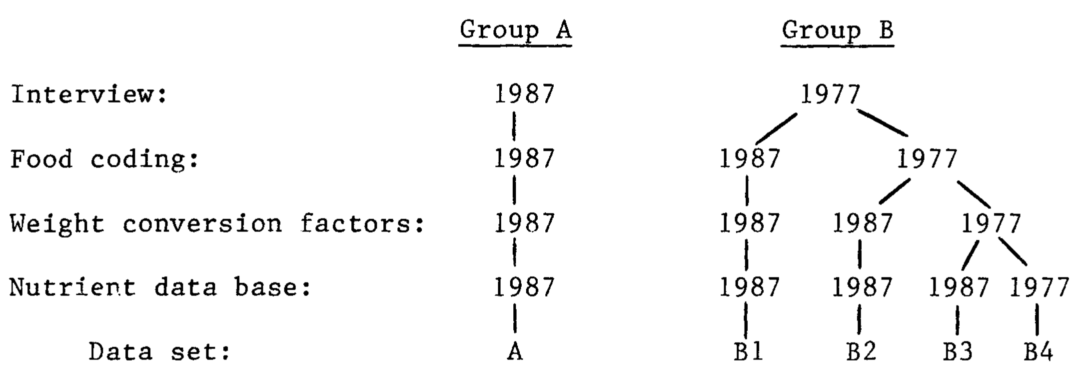

Table 1. Mean Food Energy and Selected Nutrient Intakes

Effect	Interview	Coding	Weight conversion	Nutrient data	
Data set	A	B1	B2	B3	B4
Food energy (kcal)..	1,638	1,647	1,647	1,607	1,635
Fat (g)............	67.7	67.3	67.0	65.2	69.0
Iron (mg)..........	12.0	11.6	11.7	11.4	11.1
Magnesium (g).......	206	214	216	212	233
Thiamin (mg)........	1.20	1.20	1.21	1.18	1.07
Vitamin A (IU)......	4,707	6,004	6,151	6,150	4,966
Vitamin B-12 (mcg)..	4.70	4.92	4.73	4.60	4.01

Table 2. Mean Intakes of 10 Major Food Groups

Effect	Interview	Coding	Weight conversion	
Data set	A	B1	B2	B4
	grams			
Meat, poultry, fish.........	172	194	192	184
Milk and milk products......	170	183	181	183
Eggs.......................	18	21	19	20
Legumes, nuts, seeds........	12	8	8	8
Vegetables..................	171	191	195	198
Fruits......................	125	134	142	142
Grain products..............	234	244	248	242
Fats and oils...............	15	16	16	16
Sugars and sweets...........	16	18	18	17
Beverages...................	839	839	832	827