

Effects of Procedural Differences in the Nationwide Food Consumption Survey

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Abstract: A study was conducted to assess the effects of differences in procedures in the 1987-88 Nationwide Food Consumption Survey (NFCS) and the 1977-78 NFCS. A field experiment was designed, using a split sample, to test the effects of changes in interview, food coding, and weight conversion

procedures and nutrient data bases. This paper summarizes the results of the experiment.

Key words: Bridging study; measurement error; power; split sample; trend analysis.

1. Introduction

The U.S. Department of Agriculture (USDA) has conducted surveys of household-level food use at approximately ten-year intervals since 1936. Since 1965, these surveys have also collected information on individual-level food intake. Each survey 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. As with many surveys, a tension exists between maintaining the status quo for the sake of comparability and making changes to

improve the quality of the estimates (Kasprzyk and Jacobs 1991).

A "bridging study" was conducted to determine whether 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 one-day dietary recalls even if the intakes at the two occasions were actually the same.

The same contractor conducted the Nationwide Food Consumption Survey (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 two-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

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often forgotten. Also, 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 quantities. Other than that, the basic format, flow, and content of the 1977 and 1987 questionnaires were essentially the same.

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 one cup of milk, the amount 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 more vitamin A 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 quality improvements, such as more food samples and improved analytical techniques.

A field experiment was designed to determine whether these improvements could affect survey results. A detailed a priori hypothesis testing plan was developed to answer specific research questions while limiting the number of tests performed (Guenther and Perloff 1990). The questions

included: Do the two sets of procedures (1977 and 1987) result in differences in estimated mean intakes of food energy, fat, and other nutrients or in the mean intakes of foods from ten major food groups? Then, if such differences are found, are they caused by differences in the interviewing procedures, the food coding procedures, the weight conversion factors, or the nutrient data base?

2. Design and Procedures

In this study, the procedures used in collecting, coding, and processing dietary intake data in the NFCS 1977–78 and the NFCS 1987–88 were duplicated as far as possible. 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. Only women age 20 to 49 years who were not pregnant or lactating were eligible. Because food and nutrient intakes vary greatly by age and sex, the study sample was limited to one age-sex group so that meaningful differences between treatments could be detected.

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 similar in all personal and household characteristics identified: age, height, weight, race, ethnicity (Hispanic or not), employment status, educational level, smokes cigarettes (yes or no), vegetarian

(yes or no), household income, Food Stamp Program participation, Women, Infants and Children program participation, home ownership, household size, presence of male head of household, presence of children in two age-groups in household, degree of urbanization (center city or not), and weekend versus weekday reported. Differences in means and proportions were not greater than 2 percentage points, except for household income, which differed by 5%.

Two separate groups of interviewers were trained for the two treatment conditions. They contacted each household in the sample and determined whether it had an eligible woman 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; Group B used the 1977–78 questionnaire. Like the interviewers, the reviewers, coders, and other study personnel were assigned to work exclusively 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 a comparable level of experience among all the coders.

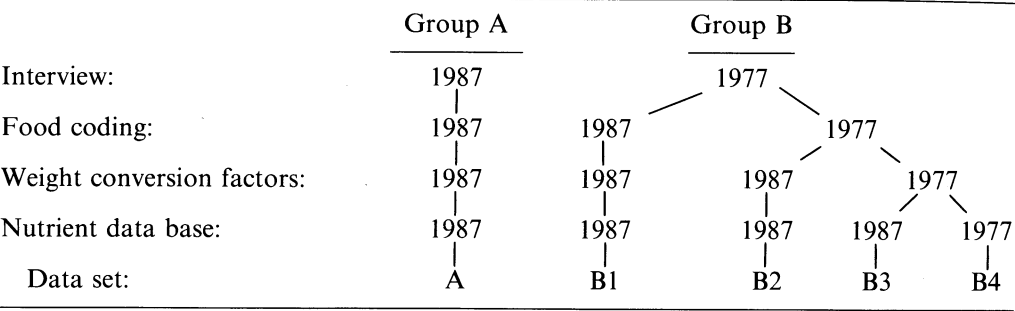
The USDA staff who answered the requests from the contractor for coding

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 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.

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 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. Data set 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 displayed in Figure 1. The various differing procedures and their possible effects on food



Difference between A and B4 is the overall difference.
Difference between A and B1 is due to interview procedures.
Difference between B1 and B2 is due to food coding procedures.
Difference between B2 and B3 is due to weight conversion factors.
Difference between B3 and B4 is due to nutrient data bases.

Fig. 1. Study design

and nutrient intake results were analyzed using SPSS-X, version 3.0 (SPSS, Inc. 1988).

3. Power and 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, greater emphasis was placed on some fat-related probes in the NFCS 1987–88 than in the NFCS 1977–78. It had been suggested that this emphasis might result in lower reported fat intakes (Committee on Diet and Health 1989).

To determine the meaningful detectable difference in fat intake, we looked at our 1977 and 1985 estimates. In the spring of 1977, our estimate of fat intake per 1,000 kilocalories was 45.3 grams for women age 19 to 50 years. In the spring of 1985, it was 40.7 grams (U.S. Department of Agriculture 1985). We decided that 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. Using estimated population variances, we determined that a sample size of 350 women in each group was required if the power of the one-tailed test was to be at least .80 at a significance level of .10 (Shavelson 1981).

Once the actual sample variances from the experiment 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 level used more often, the power would have been reduced to .75. Considering the relative risks of rejecting the null hypothesis – the Group B (1977) mean is not greater than the Group A (1987) mean – when it was true (Type I error), and of not rejecting it when it was false (Type II error), the alpha of .10 was retained for use throughout the study.

4. Results

4.1. Nutrients

Results obtained using the “pure” 1987 and the “pure” 1977 procedures are shown below in Table 1 under data sets A and B4,

Table 1. Mean intakes of food energy and nutrients.

| Nutrient | Interview: | | | | Food coding: | | | | Weight factors: | | | | Nutrient data base: | | | |
|----------|------------|----|------|----|--------------|----|------|----|-----------------|----|------|----|---------------------|----|------|----|
| | 1987 | | 1977 | | 1987 | | 1977 | | 1987 | | 1977 | | 1987 | | 1977 | |
| | | | | | | | | | | | | | | | | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| | (A) | | (B1) | | (B2) | | (B3) | | (B4) | | | | | | | |
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respectively. The effects of changes in interview procedures are represented by the differences between data sets A and B1, in food coding procedures by B1 and B2, in conversion from reported units of measure to gram weights by B2 and B3, and 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 15 nutrients were considered jointly ($p < .001$) (Norušis 1988). The univariate 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 – increases in the fat content of some of the 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 ($p < .01$). 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 ($p < .001$) but not for iron ($p = .19$). 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. Department 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 artifactual 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 iron content of 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 iron is a public health concern.

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 sweet-potatoes – 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 intake (A versus B1) 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 one-day intakes of this nutrient.

Similar nutrient data improvement, especially for potatoes and for meat, accounted for most of the difference in vitamin B-6 intakes caused by the nutrient data bases (B3 versus B4). However, this difference was not large enough to cause a statistically significant overall difference between groups (A versus B4).

4.2. Food groups

To determine if food intakes differed significantly between the two groups of women, all foods eaten were categorized into the ten major food groups shown in Table 2. Multivariate results indicated that the difference

between A and B4 was not statistically significant across the ten food group variables measured.

5. Conclusions

Two main conclusions have been drawn from this study. The first is that the changes and improvements 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. The second is that the weight conversion and nutrient data changes influenced results for some nutrients but not for others. The effects of the nutrient data improvements for iron, magnesium, and vitamins B-12 and B-6 were great enough to warrant revising the 1977 estimated intakes.

The NFCS generally conformed to a set of guidelines, 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 population at the two points in time. Unfortunately, the response rates in NFCS 1987–88 were much lower than in NFCS

Table 2. Mean intakes of 10 major food groups (grams)

| Food Group | Interview: | | | 1977 | | | 1977 | | | 1977 | | |
|--------------------------------|-----------------|-----|--|------|-----|--|------|-----|--|------|-----|--|
| | Food coding: | | | 1987 | | | 1987 | | | 1987 | | |
| | Weight factors: | | | (A) | | | (B1) | | | (B2) | | |
| | Mean | SD | | Mean | SD | | Mean | SD | | Mean | SD | |
| Meat, poultry, fish | 172 | 148 | | 194 | 176 | | 191 | 169 | | 184 | 169 | |
| Milk and milk products | 170 | 211 | | 183 | 249 | | 181 | 246 | | 183 | 250 | |
| Eggs. | 18 | 45 | | 21 | 48 | | 19 | 45 | | 20 | 47 | |
| Legumes, nuts, seeds | 12 | 49 | | 8 | 31 | | 8 | 30 | | 8 | 32 | |
| Vegetables | 171 | 178 | | 191 | 195 | | 195 | 194 | | 198 | 194 | |
| Fruits | 125 | 183 | | 134 | 188 | | 142 | 197 | | 142 | 197 | |
| Grain products | 234 | 221 | | 244 | 216 | | 248 | 221 | | 242 | 227 | |
| Fats and oils | 15 | 24 | | 16 | 26 | | 16 | 26 | | 16 | 25 | |
| Sugars and sweets | 16 | 30 | | 18 | 37 | | 18 | 34 | | 17 | 33 | |
| Beverages. | 839 | 551 | | 839 | 603 | | 832 | 604 | | 827 | 596 | |

1977–78. Although no evidence of non-response bias has been found, the potential for bias limits the inferences that can be drawn about changes in food and nutrient intakes in the target population (Life Sciences Research Office 1991), regardless of the results of the study described here.

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