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Interpretation of Dietary Change in the United States: Fat as an Indicator

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Measurement of dietary trends poses methodologic issues of great complexity and intellectural challenge. Confidence in the ability to draw inferences about trends increases when the results of various measurement methods point in the same direction, are of comparable magnitude and are consistent with one another as well as with external sources of related data. This paper illustrates these issues by reviewing inconsistencies in available data sources since the early 1970s on intake of fat in the United States.

Introduction

Rational policies to improve the health and nutritional status of populations depend on the availability of accurate information about trends in food and nutrient intake, yet such information is difficult to obtain with any acceptable degree of scientific rigor. No single independent dietary, biochemical or clinical measure is sufficient to indicate the nutritional status of individuals or populations, and no "gold standard" has yet been identified (Mertz, 1992). As each method of assessing nutritional status is limited in accuracy, validation studies can only compare data obtained by one imperfect method to another. Even so, comparative data are usually weakly correlated (Sawaya *et al*., 1996). Such difficulties affect evaluation of dietary trends, especially when methods change over time. Thus, assessment of dietary trends poses issues of especially great intellectual challenge (Nestle & Woteki, 1995) and is the subject of intense research interest (Willett & Sampson, 1997).

In the United States (U.S.), about 20 federal agencies collect data on food and nutrient intake through nearly 70 separate surveys that together comprise the National Nutrition Monitoring and Related Research Program (Interagency Board, 1992). This program resulted from a 1990 Act of Congress in part developed in response to concerns that existing surveys were incapable of identifying time trends in dietary intake patterns. As the different kinds of surveys used different methods to collect different kinds of information from different groups of people, they elicited variable and inconsistent estimates of trends (Crane *et al*., 1982; Nestle & Woteki, 1995).

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The monitoring program evaluates dietary trends through two principal types of surveys: food supply (commodities produced per capita per year, less exports, plus imports) and dietary intake (self-reports of food and beverage intake over a specified number of days obtained through interview or questionnaire). Both types convert data on the supply or consumption of foods into data on the supply or consumption of energy and nutrients. This conversion is accomplished through reference to a food composition database, corrected for serving size. Each step in the data collection and conversion processes presents opportunities for random and systematic error (Lee & Nieman, 1996). Thus, inferences about dietary time trends must be drawn with caution and must carefully distinguish genuine changes from apparent changes that result from methodologic alterations or misinterpretations.

Despite these caveats, much useful information can be obtained from dietary surveys when their limitations are considered and their results compared to other sources of related data. Confidence in the direction and size of dietary trends increases when the results of all sources of data point in the same direction, are of comparable magnitude and are consistent with one another (Nestle & Woteki, 1995). To illustrate the need for internal consistency among assessment methods, and for validation by external sources of related data, this paper evaluates the various sources of data related to changes in fat consumption in the U.S.

U.S. Fat Consumption: Data Sources

In 1988, a major research review on diet and health concluded that Americans would be healthier if they ate less fat, especially saturated fat (U.S. Department of Health, 1988). This report, however, described the surveys, but did not draw inferences from them about trends in fat consumption that might be used to confirm the need for dietary change or to evaluate the effectiveness of proposed intervention strategies. The report's oversight committee could not draw scientifically valid conclusions about time trends in consumption of fat or other nutrients on the basis of survey data, mainly because the trends deduced from food supply, dietary intake and meta-analysis data appeared to be inconsistent (Nestle & Woteki, 1995), as shown below.

Food Supply Data

From 1909, when data were first collected, to the mid-1960s, the per capita amount of fat in the U.S. food supply increased from 127 to 145 g/day (U.S. Department of Agriculture, 1967). From 1970 to 1990, the supply rose to 160–170 g/day; during this same period, the supply of saturated fat remained at about 60 g/day, and monounsaturated fat at about 67 g. The per capita supply of polyunsaturated fat, however, rose from 27 to 32 g/day, reflecting an increase in the supply of salad and cooking oils from about 15–25 pounds/year between 1970 and 1990 (Putnam & Allshouse, 1996). These trends also demonstrated replacement of fats from animal sources by vegetable fats. In the early 1900s, 75% of the fat in the food supply derived from meat, dairy, butter, lard and beef tallow, but these sources accounted for only 48% of the total fat supply in 1988; in contrast, salad and cooking oils comprised less than 2% of total fat in 1909–14, but more than 20% in 1988 (Raper *et al.*, 1992).

Food supply data indicate amounts available for consumption and are only indirect measures of dietary intake. They indicate that the amount of fat in the food supply has increased over time, and that virtually all of the increase can be accounted for by an increase in the supply of vegetable oils. At issue is the extent to which these oils are consumed. For example, fast-food outlets discard about 50% of the oil used in frying; some of this oil is rendered to be used later for animal and pet feeds, industrial purposes or export. One study has estimated that such uses account for just 9% of the total amount of fat in the food supply (Putman, 1993), suggesting that much of the fat in the food supply is available for consumption. Thus, the increase in the fat supply suggests that consumption of fat also is likely to be increasing.

Dietary Intake Data

National surveys in the U.S. have collected information about fat consumption since 1971. These surveys are conducted by two agencies: the Department of Health and Human Services (DHHS) conducts the National Health and Nutrition Examination Surveys (NHANES), and the U.S. Department of Agriculture (USDA) conducts the National Food Consumption Surveys (NFCS) and Continuing Surveys of Food Intakes by Individuals (CSFII). The intent of both sets of surveys has been to produce nationally representative data on food and nutrient intake by the civilian, non-institutionalized population (Interagency Board, 1992).

During the period 1971–1986, the results of these surveys demonstrated consistency in estimating total fat intake at 36–37% of caloric intake. The one deviation was an estimate of 40% in the 1977 NFCS; this survey reported intake of all polyunsaturated fatty acids, whereas the NHANES surveys reported intake only of linoleic acid. Response rates also were an issue in these surveys; they were only 58–64% for the interview portions of the USDA surveys, and nearly one-fourth of NHANES respondents who appeared for interviews failed to participate in the examination components. Both agencies conducted comparisons of responders and non-responders, but found no significant differences.

The surveys elicited information about fat intake through 24-h recalls, a technique much prone to error (Lee & Nieman, 1996). As an example of the consequences of recall errors, the 1976–80 NHANES and the 1977 NCHS reported similar average intakes of fat (80 and 86 g/day, respectively), but NHANES reported that 23% of respondents consumed less than 30% of energy from fat whereas NFCS identified only 6% of respondents in this category. Contributing to this discrepancy were several significant differences in data collection methods: number of days of data collection, days of the week on which data were collected, items in the food composition database, classification of foods contributing to fat intake, methods for interview and coding, and probes for alcoholic beverage consumption. When the surveys were adjusted for these differences, the discrepancies largely disappeared and adjusted data from the mid-1970s to mid-1980s suggest that fat accounted for 37–38% of energy intake throughout that decade (Nestle & Woteki, 1995).

As the NHANES surveys also measured serum cholesterol levels, investigators could correlate intake of fat and cholesterol with this independent measure, and compare any observed change with that predicted by the equations of Keys and Hegsted. Data on serum cholesterol levels did appear to be similar to predictions. Neither intake of energy, total fat and saturated fat, nor serum cholesterol, had changed significantly during that period (U.S. Department of Health, 1996a).

The NHANES survey conducted from 1988 to 1991 (NHANES III) eventually included nearly 15000 individuals who completed 24-h dietary recalls considered complete and reliable. The recall data were analysed for total energy, total dietary fat and saturated fat as a basis for drawing inferences about levels of consumption of these items for the entire U.S. population (Lenfant & Ernst, 1994). For the adult population, 34% of energy derived from total fat and 12% from saturated fat. This percentage represented a notable decrease from that observed in earlier NHANES surveys.

NHANES investigators, however, suggested that improved methods made their data more reliable than data from previous surveys. NHANES III used automated collection methods to improve data standardization, improved the protocol for probing for food sources of fat, and included additional interview questions to ensure more complete dietary recall. Its use of a different food composition database, however, impaired comparability to previous surveys. Nevertheless, the apparent downward trend in fat observed in NHANES III has been supported by more recent data from the 1994–95 CSFII (Wilson *et al*., 1997) and the Framingham Study (Millen *et al*., 1997), both of which report fat intake as 33% of energy.

In all of these surveys, the total amount of daily energy reported seems rather low. NHANES III found energy intake to be about 100–300 kcal (0·4–1·2 MJ) higher than in the previous survey; even so, average intake was just 2100 kcal/day (8·8 MJ), respectively. Such levels are lower than might be expected from average body weights in the U.S., suggesting that energy intake is underreported on surveys. Such underreporting may well be systematic, as Americans are increasingly aware of what they are supposed to be eating and may consciously or unconsciously forget intake of foods high in fat or energy (Briefel *et al*., 1997). As such analyses are not available for trend data, it is not yet possible to determine whether the increase in energy reported in NHANES is a genuine trend or an artifact resulting from changes in the assessment methods.

Meta-analysis Data

One meta-analysis of assessments of energy and fat intake has identified 171 studies drawn from more than 300 publications from 1920 to 1984 (Stephen & Wald, 1990). These studies had collected information on the dietary intake of nearly 118000 individuals of various age groups, occupations, physical conditions and ethnicities, by means of a variety of dietary assessment methods. The investigators summarized their analysis in a graph showing a gradual rise in the proportion of energy consumed as fat, from 32% in 1920 to a peak of 40–42% in the mid-1950s, followed by a gradual decline to about 36% in 1984. The investigators correlated this trend with the fall in coronary heart disease rates that has been evident since the mid-1950s. They correctly predicted that percent of energy from fat would be observed to fall to 30–35% by 1990. As the dietary intake methods and sample populations differed so widely among the 171 studies, however, it is difficult to be certain that this trend is real and not an apparent result of random or systematic errors in data collection, reporting or analysis.

Conclusions

This discussion illustrates the difficulties involved in drawing conclusions about trends in dietary intake from multiple data sources. With dietary fat as an example,

food supply data indicate an upward trend and suggest that fat consumption has been increasing; because some proportion of the fat supply may be discarded or used for non-food purposes, the relationship between fat in the food supply and that consumed is uncertain. In contrast, dietary intake and meta-analysis data suggest that the proportion of energy consumed as fat remained fairly constant from the mid-1970s to the mid-1980s, but has been declining gradually ever since. Thus, these methods yield trends of divergent direction and magnitude. Taking methodologic limitations into consideration, these data suggest that if there is a trend toward reduced fat intake, it must be quite weak.

External sources of corroborative data also yield somewhat contradictory results. Supporting a trend toward reduced fat intake is the observation that blood cholesterol levels have declined significantly since the 1970s, and both the magnitude and direction of that change are predictable from survey data (but not food supply data) on fat and cholesterol. Cardiovascular disease mortality also has declined steadily since the 1970s (U.S. Department of Health, 1996a).

Inconsistent with a reduction in dietary fat is the sharp increase in body weight observed among Americans during the past decade (U.S. Department of Health, 1996a). Fat is a concentrated source of energy. If fat intake is indeed declining, the positive energy balance that results in weight gain would have to be explained by a compensatory increase in energy obtained from carbohydrate or protein sources, a decrease in physical activity, or both. Surveys reporting declining percentages of energy from fat necessarily report increasing percentages from carbohydrate (Wilson *et al*., 1997). The alternative explanation—a marked decrease in physical activity—is not supported by existing data (U.S. Department of Health, 1996b). A third possibility is that the decline in fat intake could be an artifact of the deliberate or inadvertant underreporting of the consumption of fat-containing foods or their portion sizes. This last hypothesis is suggested by observational (Burros, 1997) and research data (Briefel *et al*., 1997; Young & Nestle, 1996), and deserves more attention than it has received to date.

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