Brief Report

Counting Calories—Caveat Emptor

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Objective.—To determine the accuracy of caloric labeling of "diet" and "health" foods and whether the accuracy differs for certain categories of food suppliers.

Design.—Survey; "diet" and "health" foods were analyzed via bomb calorimetry and categorized as regionally distributed, nationally advertised, or locally prepared.

Setting.—Foods were sampled from retail merchants throughout the borough of Manhattan, New York, NY.

Sample.—A convenience sample of 40 food items including regionally distributed (n=12), nationally advertised (n=20), and locally prepared items (n=8).

Main Outcome Measures.—Number of kilocalories per item and number of kilocalories per gram.

Results.—All locally prepared foods had more actual than labeled kilocalories. The mean percentage of actual kilocalories greater than the labeled kilocalories (mean percentage over label) per item was 85.42% (SD=77.88%; P=.01). Regionally distributed foods had significantly more kilocalories than were reported (P=.001 for kilocalories per item, P=.02 for kilocalories per gram) and mean percentage over label per item was 25.22% (SD=15.58%) and per gram was 14.97% (SD=17.95%). Nationally advertised foods did not have significantly more actual than reported kilocalories (P=.37 for per item, P=.78 for per gram). Mean percentage over label per gram was −0.01% (SD=9.13%) and per item was 2.18% (SD=13.93%).

Conclusion.—These findings suggest that food labels may be inadequate sources for caloric monitoring. Health care professionals should consider the accuracy of caloric labeling when advising patients to use food labels to help monitor their caloric intake.

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OBESITY, non–insulin-dependent diabetes mellitus, hypertension, and dyslipidemias are prevalent and chronic conditions for which dietary modification, particularly caloric restriction, is a treatment of choice.[1-3] For many people with these conditions, caloric restriction is an important treatment strategy. These patients are frequently advised to consume a set number of kilocalories per day.

Teaching patients to read food labels is a common strategy used by health professionals. Based on our experience, patients report they regularly use food labels to guide their choices. Health and weight-loss claims have been used increasingly in food advertisements during the past three decades,[4] such that even the fast-food industry has advertised caloric information in medical journals.

Although food labels can be a valuable source of information, they have also been described as a "recipe for confusion."[5] Three independent reports in the popular media demonstrated that many frozen desserts contain substantially more kilocalories than their advertised values indicate.[6-8] In one,[9] we reported that the kilocalories actually present in some products exceeded the advertised value by more than 20%, the error allowed by the Food and Drug Administration (FDA).[9] Furthermore, it appeared that companies with regionally distributed products were more likely than companies with nationally advertised products to underreport caloric content.

The purposes of the present study were to determine the accuracy of the caloric labeling of "diet" and "health" foods and to determine if the accuracy of caloric labeling differed significantly among categories of food distributors.

Methods

Sample.—Forty "diet" and "health" foods were purchased at food stores in the borough of Manhattan, New York, NY, from January through August 1992. Items were considered "diet" or "health" foods if their labels contained any of the following descriptors: "lite," "low-calorie," "reduced-calorie," "diet," "low-fat," "no-fat," or "health."

Items were categorized as regionally distributed, nationally advertised, or locally prepared. Foods prepackaged, purchased at a neighborhood grocery store, and not made by a company the investigators recognized from national advertising were considered to be regionally distributed. Nationally advertised items had brand names that were familiar to the investigators and were purchased at major supermarkets. Foods manufactured and/or prepared by the vendors (eg, restaurants and candy stores) were considered to be locally prepared.

Determination of Labeled Calories.—In all cases, regionally distributed and nationally advertised foods were labeled with information regarding caloric content. The caloric content of locally prepared foods was shown on a label, a menu, a sign, or, in four cases, a merchant's written records.

Computation of Total Actual Calories.—Bomb calorimetry was used to determine the caloric content of the food samples.[10] To minimize bias, the technician was blinded to the advertised caloric content of 36 (90%) of the 40 food items (four items had labels that could not be removed). Duplicate aliquots of each food item were subjected to bomb calorimetry. If the two measurements differed by more than 0.03 kcal (11/40 foods), a third aliquot was measured and the two closest values were retained.

To assess the reliability of the calorimetric measurements, we calculated the test-retest reliability Pearson's product moment correlation coefficient for the two aliquots used. The correlation was 0.9992 (P<.0005). In addition, the first and second calorimetric measurements for the duplicate samples were tested for statistically significant mean differences by using a dependent-samples two-tailed t test. The mean caloric measurement was 944.1 (SD=731.9) for trial 1 and 942.7 (SD=730.3) for trial 2 (t=0.31; df=39; P=.76).

The validity of the entire calorimetric analysis, including preparation of the samples, use of Atwater values,[11] and use of labeled macronutrient content, was examined by analyzing six hospital-issued enteral nutritional supplements. It was expected that these products would be labeled accurately because they are the sole source of nutrition for many hospitalized patients. After bomb calorimetry,

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the calorimetric measurements (adjusted to reflect metabolizable energy) were compared with the caloric content reported on the labels. The mean percentage of actual kilocalories greater than labeled kilocalories (mean percentage over label) was −0.43% (SD=2.99%), indicating that caloric measurements were accurate.

Computation of Metabolizable Calories.—Bomb calorimetry measures total combustible energy. In contrast, food labels are meant to reflect total metabolizable energy. Total combustible energy was converted to an estimate of metabolizable energy as follows. For nationally advertised and regionally distributed foods, labels listed the grams of protein, carbohydrate, and fat in each item. These figures were used to calculate the proportion of total energy that is metabolizable by multiplying total combustible energy by the following factor[11]: [9(Fat Grams)+4(Protein Grams)+4(Carbohydrate Grams)]/[9.45(Fat Grams)+5.65(Protein Grams)+4.10(Carbohydrate Grams)].

For locally prepared foods, information on macronutrient composition needed for the equation was not available. Thus, we estimated the proportion of total energy that was metabolizable for locally prepared foods from the average of the metabolizable energy of nationally advertised and regionally distributed foods. This value was 0.92 (SD=0.04).

Determination of the Product's Mass.—Foods were weighed using a Mettler AC-100 analytical balance (Mettler Instrument Corp, Highstown, NJ). Content weights were shown on the food labels of regionally distributed and nationally advertised foods. Manufacturers of locally prepared foods did not provide weights.

Statistical Analysis.—As expected, data violated major assumptions of parametric statistical inference (ie, normality, independence of observations, and homogeneity of variance). Thus, we used nonparametric randomization analogues to the appropriate parametric tests.[12] Randomization tests are generally the most powerful nonparametric tests and are insensitive to the above violations. Analyses were performed with Edgington's software (unpublished software, 1990).

Results

The percentages of actual kilocalories over labeled kilocalories for the nationally advertised, regionally distributed, and locally prepared foods are illustrated in Figs 1, 2, and 3, respectively. Results are depicted for both total kilocalories per item (defined as a wrapped unit) and kilocalories per gram. For nationally advertised foods (n=20; Fig 1), the mean percentage over label per gram was −0.01% (SD=9.13%) and per item was 2.18% (SD=13.93%). The actual and reported values for nationally advertised foods did not differ significantly (P=.37 for per item, P=.78 for per gram). Thus, on average, nationally advertised food items were quite accurate, particularly on a weight basis.

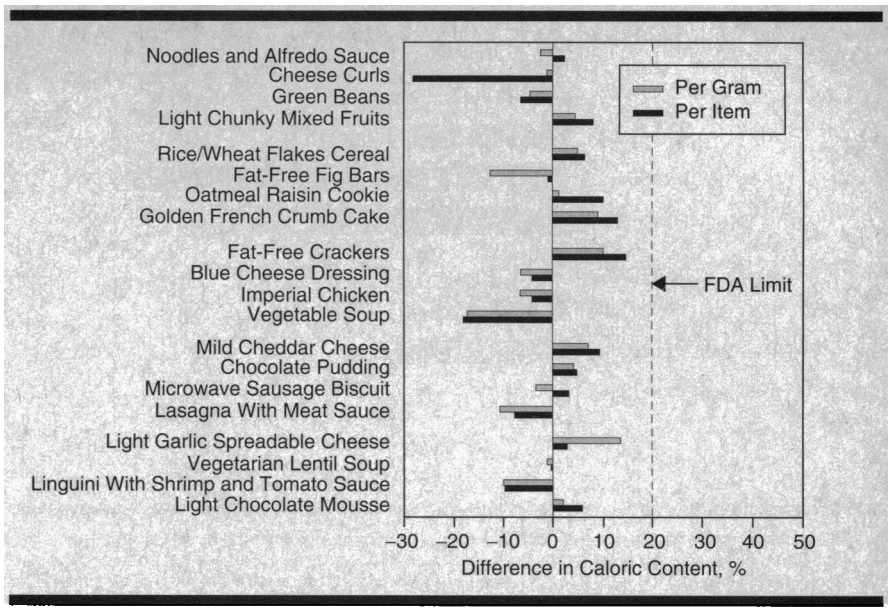

Fig 1.—Percentage difference between caloric content reported on product label and that measured by bomb calorimetry for 20 nationally advertised foods. FDA is Food and Drug Administration.

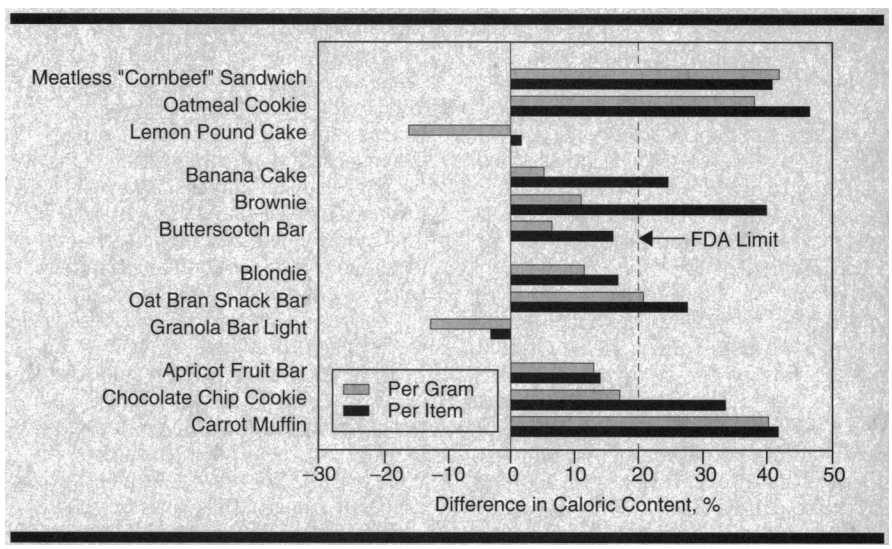

Fig 2.—Percentage difference between caloric content reported on product label and that measured by bomb calorimetry for 12 regionally distributed foods. FDA is Food and Drug Administration.

Analyses of regionally distributed foods (n=12; Fig 2) revealed that the mean percentage over labeled kilocalories per item was 25.22% (SD=15.58%) and the mean percentage over labeled kilocalories per gram was 14.97% (SD=17.95%). The actual caloric content was significantly greater than the labeled value for kilocalories per item (P=.001) and kilocalories per gram (P=.02).

In contrast to the regionally distributed and nationally advertised foods, all locally prepared foods (n=8) underreported kilocalories (Fig 3). The mean percentage over labeled kilocalories per item was 85.42% (SD=77.88%). The actual caloric content was significantly greater than the labeled value for kilocalories per item (P=.01).

When caloric reporting was compared among the groups, the caloric content of regionally distributed foods was underreported per gram (P=.004) and per item (P=.0002) more often than the caloric content of nationally advertised foods. The caloric content of locally prepared foods was underreported more than regionally distributed foods (P=.01) and nationally advertised foods (P=.0001). These results continued to be significant after the Bonferroni correction for multiple comparisons was used.

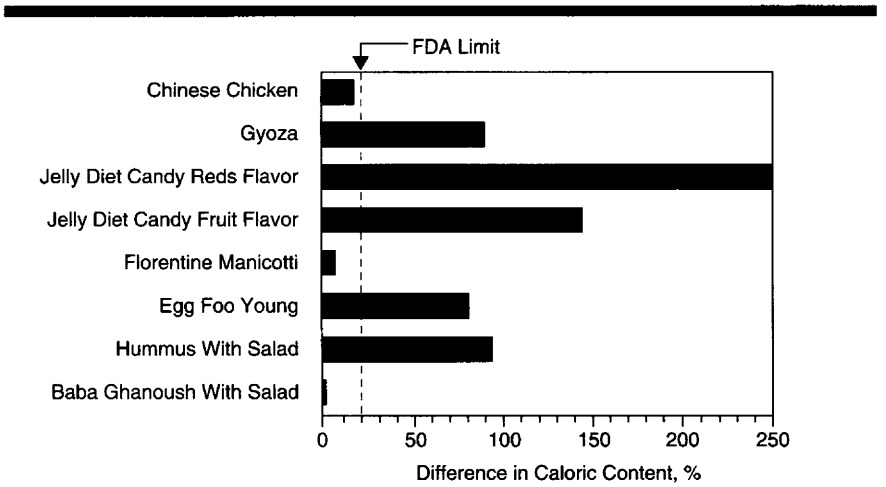

Fig 3.—Percentage difference between caloric content reported in product label or verbally and that measured by bomb calorimetry for eight locally prepared foods. (Percentage kilocalories per gram could not be calculated because manufacturers of locally prepared foods did not report item weights.) FDA is Food and Drug Administration.

Comment

Nationally advertised foods were accurate in their caloric labeling. In contrast, many regionally distributed and locally prepared health and diet foods contained substantially more kilocalories than were reported on their labels. These discrepancies were a function of differences between reported and actual weights and between reported and actual caloric density.

The greater inaccuracy of caloric reporting by manufacturers of locally prepared foods may reflect their more limited resources for performing laboratory analyses. However, if these errors were simply random, this would result in a roughly equal number of underestimates and overestimates. Instead, there seemed to be a consistent bias toward underreporting, indicating that the inaccuracy was not random error.

In the selection procedure used, the investigators simply tried to act as consumers on a calorically restricted diet and went into various stores and restaurants and looked for diet foods. Although this selection was not random, it likely reflects how a consumer selects foods and does not introduce any obvious bias. Although random sampling would have been ideal, it would require that a listing of all so-called diet and health foods be available to the investigators. Because such a list would be virtually impossible to obtain, a true random sample was not feasible.

The sampling technique imposes some potential limits on generalizability. For nationally advertised products, the results should be generalizable to the entire United States. However, use of regionally distributed and locally prepared foods may limit generalizability outside the New York area.

Regarding the validity of our computation of metabolizable energy for locally prepared foods, we assumed a constant of 0.92 as the ratio of metabolizable energy to total combustible energy. To the extent that this value did not represent the macronutrient composition of locally prepared foods, our estimate would be wrong. To determine whether this could affect our conclusion that merchants of locally prepared foods underreported the caloric content of their foods, we assumed the best-case scenario, ie, that these foods were pure protein and, therefore, had a ratio of metabolizable energy to total energy of 4.00/5.65, or 0.71. Even under these highly improbable circumstances, locally prepared products would still have a mean of 42.7% more kilocalories than reported (range, 21.71% to 169.3%).

Study subjects,[13] especially those who are obese,[14] underreport their daily caloric intake, even after considerable training in food record keeping.[15] Mertz et al stated "a thorough study of the psychological basis for (under)reporting food intake appears to be needed."[13(p294)] Our results indicate that some underreporting may result from people honestly believing that they eat fewer kilocalories than they do because they have been misinformed by food labels, although this factor is unlikely to account for all underreporting. However, because obese people may be more likely to seek low-calorie foods, they may be more susceptible to being misled in this manner.

The 1993 Nutrition Labeling and Education Act was adopted by the FDA in an effort to reestablish food label credibility.[16] One objective of this legislation was "to make available nutrition information that can assist consumers in selecting foods that can lead to healthier diets."[16(p2302)] The effective date for these revisions is February 1994 for all food merchants; restaurant firms of 10 or fewer establishments will have an additional year to comply. Despite this new legislation, our results show that the less stringent standards of current laws are frequently violated by regional and local food preparers. Thus, legislation of labeling practices appears to be insufficient. These results suggest that enforcement of labeling laws will be necessary; more stringent enforcement of food labeling laws should ultimately assist consumers in their weight-loss and weight-maintenance efforts.

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