COMPUTER DATABASE APPLICATION IN A RESEARCH SETTING

Jelia C. Witschi, M.S., R.D.

Lecturer in Nutrition, Harvard School of Public Health *

Compilation of a nutrient data-base, Nutrient Value of Foods (NVF) and programming of its interactive retrieval system, Food Finder, were initially begun for use in hyperlipidemia counseling. The primary objective was to construct a system which would be flexible, versatile, and easily accessible without coding. Programming was done in Converse language (1) on an Eclipse C-330 computer.

ORGANIZATION

A sequential code number is assigned by the computer to each food item as it is entered into the data base; it is unnecessary to prearrange groups of foods or make space allocations. Structure is achieved through the use of subtables (collections of similar food items normally referred to by commonly used food names, e.g., "salads", "sandwiches", "fruit", etc.). As each food item is entered into the data base, it is assigned to one or more of 90 + subtables, each identified by an asterisk (*). Subtables may be further incorporated into subtables (e.g., "desserts" includes "cake", "ice cream", "pie", etc., each of which is a subtable). The use of subtable names in search procedures enables greater flexibility and fast retrieval, even when the exact name of a specific food is unknown. Subtable functions permit easy creation, editing, and expansion.

Nutrients currently included in the data base are kilocalories; protein; carbohydrate; total fat, saturated, monounsaturated, and polyunsaturated fatty acids; cholesterol; sodium; potassium; and calcium. Data fields may be added as desired through the use of table functions which permit the re-definition of table size. Sodium, potassium, and calcium have been added to the table since its earlier description.(2)

Sources of nutrient information include Agriculture Handbook No. 8 Nos. 1-16 (3-18), Agriculture Handbook No. 456 (19), Agriculture Handbook No. 72 (20), Pennington and Church (21), manufacturer's information, and laboratory analysis.

Other stored information for each item includes the computer assigned codenumber, name of food, serving size, gram weight of serving, and data source(s).

Part of the rationale used in the initial construction of NVF included compositing or averaging similar food items that were low in fat content (e.g., low calorie vegetables) into a single item. Currently, both specific food items (e.g., Special K) and composited data (e.g., corn or wheat flakes), can be found in the data base. The dual approach has proved very useful in meeting varying degrees of specificity when analyzing dietary records of study participants. The NVF nutrient data base currently contains 1644 entries representing 2187 food items.

VALIDATION

Initially, the data base was validated by comparing analyses of common data sets using the new data base, hand calculations, short computation, and another computer program. The only statistically significant difference was in fat computation using the short computation method.(2) Subsequently, validation of sodium and potassium values has been accomplished through the use of duplicate meal analysis. Comparisons between computer and laboratory estimates of sodium in 24-hour food collections gave a correlation coefficient of 0.75 ($p<.001$).(22)

MAINTENANCE

Edit functions permit easy access to NVF and its subtables for the purpose of updating, correcting, or adding new food items. Additional nutrients are added by creating new fields. Documentation of NVF is maintained in notebooks containing work sheets with all relevant data including dates of inclusion or updating for each item. Changes are planned in notebook format prior to computer entry.

RETRIEVAL

A retrieval program, Food Finder, was written for on-line, interactive, rapid retrieval, and subsequent analysis of dietary data. Assistance is available on line at the beginning of the interview, as shown in Fig. 1, or is accessed by a question mark (?) wherever help is needed. Procedures for entering data to be analyzed include the following computer prompted steps (see Fig. 2):

1) access Food Finder program
2) assign ID number or name
3) enter recording date
4) enter food name or first few letters of food name; or subtable name or first few letters of subtable name; or computer assigned code number
5) accept quantity statement or convert to appropriate quantity (based on gram weight)
6) enter appropriate whole number and/or decimals of units for quantity desired
7) continue entering food items to completion
8) when all foods are entered, program prompts entry of number of days (divisor)

GENERATING SUMMARIES

A summary can be available immediately at the termination of the interview. Using stored responses of food types and quantities, individual or batch summaries by date range (date of analysis) may be generated. A typical summary (see Fig. 3) gives ID number (or name, if used), date of interview, reiteration of all foods entered (duplicate entries are added at point of first mention), and nutrient computation (total and average per day).

A dietary evaluation (see Fig. 3) based on recommendations of the American Heart Association (23) and the National Cholesterol Education Program (24) compares actual (calculated) and recommended P/S ratio, cholesterol (mg/day), and sodium (mg/day); and displays the percentage distribution of calories for protein, carbohydrate, total fat, and for saturated and polyunsaturated fatty acids.

USAGE

An experienced user can process 10-15 1-day records/hour using the Food Finder program. Minimal training is necessary to acquaint a new user with the system and to become proficient in its use.

Costs of the system including computer costs, summary, and storage range from $1.50 - $2.00 for 1-day records or interviews to $3.00 - $3.50 for 7-day records.

COMPUTER DATABASE APPLICATION IN A RESEARCH SETTING

The system readily lends itself to research applications. Accuracy is increased by multiple conversion possibilities and specificity is enhanced by the ease of editing or adding foods to the data base. Using an adaptation of Food Finder, Recipe Analysis, approximately 300 institutional recipes have been calculated and added to NVF for use in specific studies.

During the past four years approximately 20,000 days of recorded dietary data has been analyzed by 1 or 2 dietitians working part-time. This data emanated from 4 studies in which 1-7 days of recorded dietary data per collection period was obtained.

An educational benefit has been realized by using Food Finder and other interactive nutrition counseling programs to assist in teaching dietary methodology. Students have appreciated the immediate feedback and instruction, and many have requested, for personal reasons, repeated analysis and counseling.

DISCUSSION

The use of automated systems speeds the process of decision making in selecting appropriate food items, quantifying, and analyzing large amounts of dietary data.

The use of computers unquestionably improves accuracy in dietary analysis by the obvious reduction of arithmetic errors. In many instances, however, accuracy is compromised because of errors made in manual coding. Jacobs et al. (25) compared 1-day dietary records from 54 subjects analyzed by three different data bases and determined that the most frequent source of error resulted from hand calculation and from systematic errors in coding.

Overall accuracy in recorded dietary methods depends on a three-way interaction. The recorder influences accuracy through a variety of observational and measurement skills and through immeasurable attitudes and motivations. The ability of the interpreter of the record to avoid subjective bias, to ask relevant questions, and to be aware of current food practices adds a considerable dimension to the accurate outcome of the record. Finally, the skillful use of an appropriate table of nutrient values is important to accuracy, but precision is not expected. Except in metabolic ward situations where food analysis is specifically tailored to the immediate study, nutrient data bases cannot provide exact measures of nutrients consumed. Nutrient data is customarily derived from the analysis of food samples from various sources and therefore cannot be totally accurate in a given situation.

SUMMARY AND CONCLUSIONS

A nutrient data base, NVF, and its retrieval system, Food Finder, have been described. NVF and its subtable organizational system are designed to be versatile, flexible, easily updated and expanded. Food Finder provides on line, interactive, and rapid retrieval of food items without the necessity of coding. Use and application of the system have been described and demonstrated.

* Supported by The Center for Clinical Computing, Department of Medicine, Harvard Medical School, Beth Israel and Brigham and Women's Hospitals, Boston. Special thanks to Holly Kowaloff, programming specialist.

REFERENCES

1. Bloom, S., White, R., Beckley, R., and Slack, W.: Converse: A means to write, edit, administer and summarize computer-based dialogue. Computer Biomed Res 11: 167, 1978.

2. Witschi, J., Kowaloff, H., Bloom, S., and Slack, W.V.: Analysis of dietary data: An interactive computer method for storage and retrieval. J Am Diet Assoc 78: 609-13, 1981.

3. Posati, L.P. and Orr, M.L.: Composition of Foods: Dairy and Egg products - Raw, Processed, Prepared. Agriculture Handbook No. 8-1. Consumer and Food Economics Institute, USDA. Rev. 1976.

4. Marsh, A.C., Moss, M.K., and Murphy, E.W.: Composition of Foods: Spices and Herbs -- Raw, Processed, Prepared. Agriculture Handbook No. 8-2. Consumer and Food Economics Institute, USDA. Rev. 1977.

5. Gebhardt, S.E., Cutrufelli, R., and Matthews, R.H.: Composition of Foods: Baby Foods -Raw, Processed, Prepared. Agriculture Handbook No. 8-3. Consumer and Food Economics Institute, USDA. Rev. 1978.

6. Reeves, J.B. III and Weinrauch, J.L.: Composition of Foods: Fats and Gils - Raw, Processed, Prepared. Agriculture Handbook No. 8-4, Consumer and Food Economics Institute, USDA. Rev. 1979.

7. Posati, L.P.: Composition of Foods: Poultry Products - Raw, Processed, Prepared. Agriculture Handbook No. 8-5, Consumer and Food Economics Institute, USDA. Rev. 1979.

8. Marsh, A.C.: Composition of Foods: Soups, Sauces and Gravies - Raw, Processed, Prepared. Agriculture Handbook No. 8-6. Science and Education Administration,USDA. Rev. 1980.

9. Richardson, M., Posati, L., and Anderson, B.A.: Composition of Foods: Sausages and Luncheon Meats - Raw, Processed, Prepared. Agriculture Handbook No. 8-7. Science and Education Administration, USDA. Rev. 1980.

10. Douglass, J.S., Matthews, R.H., and Hepburn, F.N.: Composition of Foods: Breakfast Cereals - Raw, Processed, Prepared. Agriculture Handbook No. 8-8. Consumer Nutrition Center, USDA. Rev. 1982.

11. Gebhardt, S.E., Cutrufelli, R., and Matthews, R.H.: Composition of Foods: Fruits and Fruit Juices - Raw, Processed, Prepared. Agriculture Handbook No. 8-9. Consumer Nutrition Center, USDA. Rev. 1982.

12. Anderson, B.A.: Composition of Foods: Pork Products - Raw, Processed, Prepared. Agriculture Handbook No. 8-10. Consumer Nutrition Division, USDA. Rev. 1983.

13. Haytowitz, D.B. and Matthews, R.H.: Composition of Foods: Vegetables and Vegetable Products - Raw, Processed, Prepared. Agriculture Handbook No. 8-11. Nutrition Monitoring Division, USDA. Rev. 1984.

14. McCarthy, M.A. and Matthews, R.H.: Composition of Foods: Nuts and Seed Products - Raw, Processed, Prepared. Agriculture Handbook No. 8-12. Nutrition Monitoring Division, USDA. Rev. 1984.

15.Anderson, B.A., Lauderdale, J.L. and Hoke, M.I.: Composition of Foods: Beef Products - Raw, Processed, Prepared. Agriculture Handbook No. 8-13. Nutrition Monitoring Division, USDA. Rev. 1986.

16.Cutrufelli, R. and Matthews, R.H.: Composition of Foods: Beverages - Raw, Processed, Prepared. Agriculture Handbook No. 8-14. Nutrition Monitoring Division, USDA. Rev. 1986.

17.Exler, J.: Composition of Foods: Finfish and Shellfish Products - Raw, Processed, Prepared. Agriculture Handbook No. 8-15. Nutrition Monitoring Division, USDA. Rev. 1987.

18.Haytowitz, D.B. and Matthews, R.H.: Composition of Foods: Legumes and Legume Products Raw, Processed, Prepared. Agriculture Handbook No. 8-16. Nutrition Monitoring Division, USDA. Rev. 1986.

19.Adams, C.F.: Nutritive Value of American Foods in Common Units. Agriculture Handbook No. 456. Agricultural Research Service, USDA. 1975.

20.Nutritive Value of Foods. Home and Garden Bulletin No. 72. Science and Education Administration, USDA. Rev. 1981.

21.Pennington, J.A.T. and Church, H.N.: Food Values of Portions Commonly Used. Thirteenth Ed. New York: Harper and Row, 1980.

22.Witschi, J.C., Ellison, R.C., Doane, D.D., Vorkink, G.L., Slack, W.V., and Stare, F.J.: Dietary sodium reduction among students: Feasibility and acceptance. J Am Diet Assoc 85: 816-21, 1985.

23.American Heart Association. Dietary guidelines for healthy American adults: A statement for physicians and health professionals by the Nutrition Committee,American Heart Association. Circulation 74(6): 1465A-68A, 1986.

24.Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. National Cholesterol Education Program, coordinated by the National Heart, Lung and Blood Institute, National Institute of Health, PublicHealth Service, U.S. Department of Health and Human Services. Oct. 5, 1987.

25.Jacobs, D.R., Elmer, P.J., Gorder, D., Hall, Y., and Moss, D.: Comparison of nutrient calculation systems. Am J Epid 121: 580-592, 1985.

FIGURE 1. ILLUSTRATION OF ON-LINE ASSISTANCE

Underlined words indicate user response

Would you like a quick review of how to use this program?
1. YES
2. NO

Answer: 1

Which of these would you like to review?
1. SEARCH FOR FOOD ITEM
2. CONVERSION FOR SERVING SIZES
3. NUMBER OF SERVINGS
4. TERMINATING THE INTERVIEW
5. OBTAINING THE SUMMARY
6. NO REVIEW

ANSWER (AS MANY AS YOU WISH): 1

There are several ways to search for a food item:
1. NAME
2. SEVERAL LETTERS
3. SUBTABLE NAME
4. CODE NUMBERS
5. QUESTION MARKS ENTERED

Which of these would you like to review?
ANSWER (ANY YOU WISH): 2

You may not need to type the whole name of a food. In many instances, only a few letters are necessary to distinguish a specific food item...

In the search for beef stew, for example, typing 'B' would display all foods beginning with this letter; 'BEEF', all foods beginning with this word; 'BEEF S'would further narrow the search to BEEF SPREAD, BEEF STEW, BEEF STROGANOFF, etc.

The idea is to be as brief and specific as possible.

FIGURE 2. ILLUSTRATION OF DATA ENTRY

Underlined words indicate user response.

OK, THEN LET'S GET ON WITH THE FOOD ANALYSIS...

PLEASE ENTER FOOD RECORD ID: 136s

PLEASE ENTER THE RECORDING DATE IN MM/DD/YY FORMAT: 03/26/88

FOOD: PANCAKE
Serving size: 1 6" //
# of servings: 2

FOOD: MARGARINE *
1. STICK MARGARINE
2. SOFT MARGARINE
3. WHIPPED MARGARINE
4. LIQUID MARGARINE
5. IMITATION MARGARINE
6. MARGARINE (LOW SODIUM)
7. MARGARINE (CORN OIL)
8. SOFT MARGARINE (INC POLY)
9. BUTTER BLEND (LOW SODIUM)
10. BUTTER BLEND
11. MARGARINE (CANOLA OIL)
12. WHIPPED MARGARINE (INC POLY)

ANSWER: 2
SERVING SIZE: 1 TSP //
OF SERVINGS: 2

FOOD: 336 (SYRUP)
SERVING SIZE: 1 TB //
OF SERVINGS: 2

FOOD: FRUIT J
316. FRUIT JUICE (SWEETENED)
317. FRUIT JUICE (UNSWEETENED)
451. FRUIT JUICE *

ANSWER: 317 (FRUIT JUICE UNSWEETENED)
SERVING SIZE: 1 CUP // 7 (OUNCE(FL.))
OF SERVINGS: 6

FOOD: POPT
472. POPTARTS

SERVING SIZE: 1
OF SERVINGS: 1
FOOD:
ARE THERE ANY MORE FOODS?
1. YES 2. NO

ANSWER: 2
HOW MANY DAYS OF FOOD IS THIS: 1

FIGURE 3. SAMPLE SUMMARY AND DIETARY EVALUATION

ID NUMBER 136s RECORDING DATE: 03/26/88

FOODS: 6 x 1 6" PANCAKE, 5.0 x 1 TSP SOFT MARGARINE, 3.25 x 1 TB SYRUP, 9.893 x 1 CUP FRUIT JUICE (UNSWEETENED), 1 X 1 POPTARTS, 1.5 X 1 TB PEANUT BUTTER (SALTED), 1 X 1 TB MARSHMALLOW FLUFF, 3.5 X 1 SLICE BREAD (WHEAT, WHITE, ETC.), 2.0 X 1 RAISINS, .8 X 10 FRENCH FRIES, 1 X 1 TB CATSUP, 7 X 1 COOKIES WITH FROSTING OR FILLING, .625 X 1 CUP WATER, 1 X 1 CUP PRESWEETENED RICE KRISPIES, .5 x 1 CUP TUNA SALAD, .734 X 1 CUP LOW FAT MILK (1%), 3 x 1 CHOCOLATE CHIP COOKIE, 1 x 10 MEDIUM RIPE OLIVES, .25 x 1 MED CARROT (RAW), .84 x 1 CUP MASHED POTATO, 2 x 1 SEC WAFFLES, .5 x 1 aPPLE, .2 x 10 BUTTER CRACKERS, .667 x 3 OZ ROUND STEAK. .005 x 1 TSP SALT.

	TOTAL	AVERAGE/DAY	
CALORIES	4993.	1664.4	
PROTEIN/GM	124.3	41.4	
CHO/GM	813.9	271.3	
FAT/GM	146.0	48.7	
SAT FAT/GM	39.3	13.1	
MONO FAT/GM	62.3	20.8	
POLY FAT/GM	31.0	10.3	
CHOL/MG	380.3	126.8	
SODIUM/MG	6244.9	2081.6	(90.5 MEQ)
POTASSIUM/MG	7529.3	2509.8	(64.2 MEQ)
CALCIUM/MG	1835.8	611.9	

DIETARY EVALUATION

	ACTUAL	RECOMMENDED
P/S RATIO	.79	1.0
CHOLESTEROL	127 MG	<300
SODIUM	2082 MG	1100-3300

CALORIC DISTRIBUTION (1664 CALORIES)

PROTEIN	10.0%	12-15%
FAT	26.3%	<30%
POLYUNSATURATED FAT	5.6%	>10%
SATURATED FAT	7.1%	<10%
CARBOHYDRATES	63.7%	55-58%