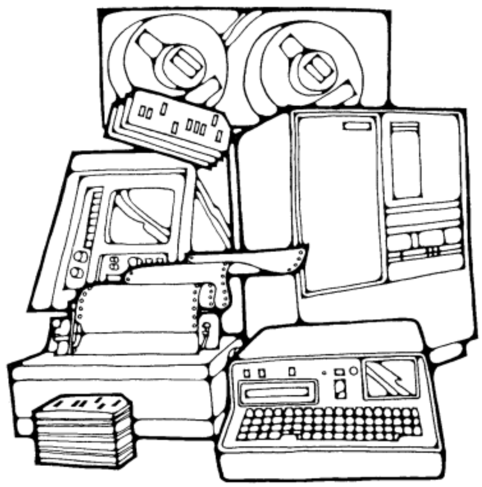

11th National Nutrient Databank Conference

Meeting the Needs for the Future in Diet and Health Research

June 29 - July 2, 1986

Georgia Center for Continuing Education
The University of Georgia

Athens, Georgia

- British Nutrient Database
  Derek Singer, Ph.D.
- Using USDA Data Tapes
  Betty Perloff and Brucy Gray
- Ethnic Recipes - Networking for Progress
  Linda Hicks, M.Ed., R.D.
  Patricia Pillow, R.D.
- Database Validation Procedures
  Marilyn Buzzard, Yvonne Sievert, Sally Schakel
- Data Integrity - Methods for Data Validations
  Suzanne Murphy
- Linking Survey Nutrient Databases - 1977-78 NFCS to CSFn 1985
  Alanna Moshfegh, R.D.
- Integrating Nutrient Data with Food Frequency Data
  Elizabeth Randall, Ph.D.
- Food Descriptor/Coding Schemes
  Joanne Holden

Innovations in the World of Nutrient Databanks

- Recipe Calculations - New Research in Methodologies
  Pat Powers, M.S., R.D.
- Setting Up a Regional Nutrient Databank Users Group
  Debra Reed, Ph.D., R.D.

Relationships Between Diet and Health Performance

- Food Frequency and Related Methods to Study Dietary Problems in Georgia
  W.O. Caster, Ph.D.
- Food Determinants for Specific Dietary Carbohydrates
  G.G. Dull, Ph.D. and W.O. Caster, Ph.D.
- Differences in Diets of Mothers of Preschool Children From Two Income Groups
  Anna Resurreccion, Ph.D. and Lily Paguio, Ed.D.
- Cultural Diet Patterns in Benin, West Africa
  J. Caldwell-Ryan, Ph.D. and W.O. Caster, Ph.D.

Keynote Presentation

- Meeting the Needs of the Future in Diet and Health Research
  L.J. Filer, Jr., M.D., Ph.D.
- Hardware Considerations
  Marge Alford, R.D.

Abstracts:

- "Comparison of Coding and Nutrient Calculation Systems,"
  Patricia D. Catsos, Yvonne A. Sievent, Mary J. Stevens, Margo Woods, I. Marilyn Buzzard
- "Dietary Data Collection System,"
  Diane Feskanich, I. Marilyn Buzzard

INTRODUCTION

The Nutrient Databank Conference provides a unique opportunity for professionals from industry, academia, the health care arena, and government to discuss all aspects of Nutrient Databank Technology. The interdisciplinary nature of the conference offers a stimulating atmosphere to exchange new ideas and interact with individuals with similar interests.

The contents of these proceedings are a compilation of papers presented by various program participants during the 1986 Annual Conference. The University of Georgia accepted the papers as presented in order to expedite the delivery of this manuscript during the Conference; therefore, some variations exist.

We hope you will find this publication helpful as you continue your pursuit of Nutrient Databank technology.

Local Arrangements Committee:

Bill Caster, Chair

Wanda Grogan, Co-Chair

Trudy Cain

Nancy Canolty

Program Committee:

Nancy Rawson, Chair

Marilyn Buzzard

Stephanie Ference

Susan Forester

Linda Hicks

Karen Morgan

Linda Posati

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PROGRAM COORDINATED BY:
THE UNIVERSITY OF GEORGIA
COLLEGE OF HOME ECONOMICS
GEORGIA CENTER FOR CONTINUING EDUCATION

USDA Update
Frank N. Hepburn
Human Nutrition Information Service

Recent publications and publication plans for 1986:

HG-72	Nutritive Value of Foods (published)

AH-8-13	Beef Products (in press)
AH-8-14	Beverages (published)
AH-8-15	Finfish and Shellfish Products (in preparation)
AH-8-16	Legumes (in preparation)

Provisional Table on Omega-3 Fatty Acids (published)
Provisional Table on Vitamin K (in press)
Provisional Table on Sugars (in preparation)
Provisional Table on Vitamin D (in preparation)

Recent machine readable tapes made available through NTIS:

USDA Nutrient Data Base for Individual Food Intake Surveys, Release 2, 1986 (accession number PB86-206299/HBF)

Data sets used to create USDA Nutrient Data Base for Individual Food Intake Surveys, Release 2 (accession number PB86-206281/HBF):

1. Recipe File for Release 2 of USDA Nutrient Data Base for Individual Food Intake Surveys

2. Primary Nutrient Data Set for USDA Nationwide Food Consumption Surveys, Release 1

3. USDA Table of Nutrient Retention Factors, Release 1

Plans for publications in 1987:

AH-8-21	Fast Foods
AH-8-17	Lamb, Veal and Game
AH-8-19	Sugars and Sweets
HG-90	Conserving Nutritive Values (revision)
HERR-	Sugars in Foods

Provisional Table on Dietary Fiber

Plans for publications in 1988:

AH-8-18	Baked Products
AH-8-20	Cereal Grains, Pastas, Snacks
AH-8-22	Mixed Dishes
AH-8-23	Miscellaneous Foods
AH-102	Food Yields (revision)

We are using information available in the Primary Nutrient Data Set,together with consumption data from the 1985 CSFII to set priorities for foods and nutrients to be studied in analytical studies. The source code in the Primary Nutrient Data Set provides information on the relative strengths and weaknesses of the data; the food consumption data provides information on the importance of foods in supplying each nutrient to the daily diet. We have submitted plans for several contracts based on these factors, which will strengthen the comprehension and validity of our data bases. They are, of course, subject to the availability of funds.

We continue to work closely with the Nutrient Composition Laboratory (NCL) at Beltsville, Maryland, in efforts to improve and develop new analytical data. Two of the current cooperative efforts include a study on nutrients in sweet bakery foods and a major study on measuring the content and variability of selenium in foods in the U.S. The plan for the selenium study was developed cooperatively, using information on selenium content of foods culled from the literature by Nutrient Data Research (NDRB) staff and evaluated by NCL staff. By adding selenium values to the Primary Data Set, the contribution of foods to the selenium intake of individuals in the 1985 CSFII study was measured. The NCL is now in the process of collecting some of the samples and preparing them for analysis. The study incorporates built-in quality control checks and employs the use of reference materials to assure the validity of results. We believe this study will serve as a model for establishing a standard protocol for generating reliable data.

An update on the assessment of analytical methodology has been provided by Dr. Beecher and is appended to this report.

STATE OF DEVELOPMENT OF METHODS FOR NUTRIENTS IN FOODS
Nutrient Composition Laboratory
BHNRC, ARS, USDA
Beltsville, MD 20705
April 1986

Nutrient category	State of Methodology[a/] Adequate	Substantial	Conflicting	Lacking
Carbohydrates, fiber and sugars		Individual sugars Fiber (AOAC) Starch	Fiber components	
Energy	Bomb calorimetry		Calculated	
Lipids		Cholesterol Fat (total) Fatty acids (common)	Sterols Fatty acids (isomers)	
Minerals/Inorganic nutrients	Calcium Copper Magnesium Phosphorus Potassium Sodium Zinc	Iron Selenium	Arsenic Chromium Fluorine Iodine Manganese	Cobalt Molybdenum Silicon Tin Vanadium Molecular species
Proteins and amino acids	Nitrogen (total)	Amino acids (most)	Amino acids (some) Protein (total)	
Vitamins		Niacin Riboflavin Thiamin Vitamin B-6 Vitamin E	Vitamin A Vitamin B-12 Vitamin C Vitamin D Pantothenic acid	Biotin Carotenoids (pro-vit.A) Choline Folacin Vitamin K
Other			Phytate	Carotenoids (non-vit.A)

a/ Description of methodology states

Factors	Adequate	Substantial	Conflicting	Lacking
Accuracy	Excellent	Good	Fair	Poor
Speed of analysis	Fast	Moderate	Slow	Slow
Cost per analysis	Modest (<$100)	Modest to high	High	?
Development needs	---	Method modif. Extraction proc. Applications	Method develop. modif. Extraction proc. Applications	Method develop. Extraction proc. Applications

UPDATE OF THE TOTAL DIET STUDY: SELECTED MINERALS IN FOODS SURVEY

Jean A.T. Pennington, Ph.D., R.D.
Division of Nutrition, Food and Drug Administration
Washington, D.C.

The Total Diet Study program allows the Food and Drug Administration (FDA) to monitor the levels of nutritional elements and contaminants in the United States food supply and to estimate the intake levels of these substances in the diets of selected age-sex groups. This program, which operates on a yearly basis, began in 1961 and underwent a significant revision in April 1982 to update the food list and diets, to increase the coverage of age-sex groups, and to analyze individual foods rather than food commodity groups.

Previous results from the Selected Minerals in Foods Survey, which is the portion of the Total Diet Study program that concerns nutritional elements, are summarized in Table 1. These results, obtained between 1974 and 1982, were based on diets developed from food consumption data of the 1965 U.S. Department of Agriculture (USDA) Household Food Consumption Survey. As indicated in Table 1, the diet of the adult male was adequate in calcium, phosphorus, magnesium, iron, potassium, manganese, and selenium; low in zinc and copper; and elevated in iodine and sodium. The dietary level of sodium included that from discretionary salt. The diet of the six-month-old infant was adequate in calcium, phosphorus, magnesium, zinc, potassium, manganese, and selenium; low in iron and copper; and elevated in iodine and sodium. The diet of the two-year-old child was adequate in calcium, phosphorus, magnesium, potassium, manganese, and selenium; low in iron, zinc, and copper; and elevated in iodine and sodium. The sodium levels of infant and toddler diets did not include that from discretionary salt. The major sources of iodine in these diets were the milk and dairy products commodity groups and the grain and cereal products commodity groups.

The current Total Diet Study program includes four collections per year, each from one of four geographical locations (east, west, south, and central). For each collection, the purchase and delivery of the foods takes four weeks, and the subsequent preparation and analyses of the food samples takes approximately two months. For each collection foods are obtained from three designated cities within the specified geographical area. The selected cities, which vary from year to year, represent standard metropolitan statistical areas and are in close proximity to FDA district offices.

Foods are sent to the Total Diet Laboratory in Kansas City, Missouri; those requiring preparation and/or cooking are sent to a contract kitchen and then returned to the Total Diet Laboratory for analyses. The three subsamples of each food from the three cities are composited prior to analyses. The concentrations of each nutrient or contaminant in each food from the four yearly collections are averaged. The food composition data are then merged with the food consumption data to estimate daily intake levels of the substances for the eight age-sex groups.

The analytical methods used to determine the eleven nutritional elements include inductively coupled plasma atomic emission spectroscopy (ICP-AES) for sodium, potassium, calcium, phosphorus, magnesium, iron, zinc, copper, and manganese; a colorimetric method for iodine; and atomic absorption spectrometry with rapid hydride evolution for selenium. Each series of 20-30 laboratory samples is accompanied by two blanks, one spiked laboratory sample, one laboratory sample in duplicate, and a standard reference material for each element. Questionable results require reanalysis of the entire series.

The 234 foods included in the Total Diet Study are based on results from the 1977-78 USDA Nationwide Food Consumption Survey (NFCS) and the Second National Health and Nutrition Examination Survey (NHANES II), which was conducted by the National Center for Health Statistics between 1976 and 1980. The Total Diet Study foods were selected on the basis of daily gram weight intake and frequency of consumption as indicated in these two national surveys. The 3700 foods in the NFCS data base and the 2600 foods in the NHANES II data base were aggregated according to food source and nutrient content. Foods within an aggregate that were consumed in the largest quantities were chosen to represent the aggregate. These aggregate representatives are the 234 Total Diet Study foods. The foods include dairy, meat, grain, fruit, and vegetable products, mixed dishes and soups, desserts, fats and sauces, sweeteners, beverages, and commercial infant foods and formulas. The diets developed for the eight age-sex groups contain typical quantities of these foods and have caloric values representative of these groups.

The results for the first two years (1982/83 and 1983/84) of the revised Total Diet Study are indicated in Table 2. Calcium was adequate for infants, teenage boys, and adult males, but low for the other groups. The calcium levels of the diets of teenage girls, adult women, and older women were especially low (61 to 71% of the Recommended Dietary Allowance (RDA)). Phosphorus was adequate for all diets, but a bit low (89% RDA) for the teenage girl. Magnesium was adequate for infants and toddlers, but low for teenagers, adults, and older adults. Magnesium was especially low (61 to 64% RDA) for teenage girls, adult women, and older women. Iron was low for infants, toddlers, teenage girls, and adult women. The latter three groups met only 56 to 59% of the RDA. Iron requirements were adequately met by teenage boys, adult men, and older men and women. Zinc levels were adequate for infants, teenage boys, and adult men, but low for other groups. The zinc levels of the diets of teenage girls, adult women, and older women were especially low (57 to 66% RDA). Iodine levels were high for all groups (1.7 to 6.6 times the RDA).

Major sources of iodine were milk and dairy products, fish, and various commercial products that were thought to contain iodine-containing food additives such as iodized salt, erythrosine (FD&C Red No. 3), iodate dough conditioners, and/or carrageenan. The iodine in milk and dairy products results from the use of iodine supplements in cattle feed (to prevent iodine deficiency and mistakenly thought to prevent various diseases a improve reproductive efficiency) and from the use of iodophor disinfectants used to clean cattle and dairy equipment. Because these diets do not contain iodine from discretionary iodized salt, the iodine levels reported here are underestimated for those who use this product.

Levels of sodium, potassium, copper, manganese, and selenium in the Total Diets are compared with Estimated Safe and Adequate Daily Dietary Intakes (ESADDIs) in Table 2. The sodium levels of these diets did not include discretionary salt (that added at the table). However, items made according to a recipe contained added salt if specified by the recipe, and many of the commercially prepared food items contained added salt. The sodium levels of the diets were within the ESADDI ranges except for the diets of the toddler and teenage boy, which exceeded the ESADDI range. Potassium levels were within the ESADDI ranges, except for the infant diet, which exceeded the upper range. Copper levels were below the ESADDI ranges for all age-sex groups. Manganese levels were within ESADDI ranges for toddlers, teenage boys, adult males, and older males; above the range for infants; and below the range for teenage girls, adult women, and older women. Selenium levels were within the ESADDI ranges for all age-sex groups.

Results for the third year (1984/85) of the Total Diet Study are undergoing review, and results of the fourth year should be available by July 1986. At that point, the yearly results from 1982/83 to 1985/86 will be analyzed to determine if any significant trends in nutrient intake are apparent. Preliminary results from the first three years, which have not yet been statistically evaluated, indicate that sodium levels of the diets have been decreasing by about three percent per year and that iodine levels dropped about 50% between the second and third years.

The toxic elements arsenic, cadmium, lead, and mercury are also routinely analyzed in the Total Diet Study as part of the contaminants program. The results for these elements and other contaminants are evaluated and reported by the Division of Chemical Technology of the FDA. The data for the first two years of the revised Total Diet Study indicated that the levels of lead, mercury, and cadmium in daily diets were below the provisional tolerable intakes established by Food and Agricultural Organization/World Health Organization. Provisional tolerable levels for arsenic have not been established, but the levels found in the Total Diet Study were acceptable.

The Total Diet Study is part of the National Nutrition Monitoring System. The Selected Minerals in Foods Survey of the Total Diet Study allows for continued yearly monitoring of the typical levels of nutritional elements in foods and diets. The unique features of this survey are that it provides yearly data; it includes some nutritional elements (e.g., copper, manganese, selenium, and iodine) not evaluated in other surveys; and the values are obtained from direct laboratory analyses.

The results from the Selected Minerals in Foods Survey assist FDA in making policy decisions concerning manufacturing and agriculture practices, nutrient fortification, and use of food additives. For example, the high levels of iodine noted in previous Total Diet Studies and seen in current results uphold FDA's decisions to limit the levels of iodine in permitted food additives and to not allow for any new food additives containing iodine. FDA has also encouraged the dairy industry to use only the amount of iodine feed supplement and iodophor solutions necessary for their respective functions and to avoid excess. With regard to sodium and the concern about the association of this element with hypertension, FDA has encouraged industry to reduce the levels of sodium in food products. As mentioned, preliminary results from the first three years of the revised Total Diet Study indicate trends that might be consistent with industry compliance to FDA requests.

Samples from one Total Diet Study collection in 1985 were forwarded to the Division of Chemical Technology in Washington, D.C. and analyzed by ICP-AES for several additional elements of interest to FDA. These elements included aluminum, molybdenum, cobalt, nickel, vanadium, and strontium. The results for aluminum have been submitted for publication. They indicated rather modest intakes of this element in comparison with previous reports of aluminum consumption. Major dietary sources of aluminum were processed cheese containing an aluminum additive, baked products containing aluminum additives in the baking powder, and tea. A paper concerning the data for molybdenum, cobalt, nickel, vanadium, and strontium is undergoing agency clearance.

The Selected Minerals in Foods Survey will continue on a yearly basis to monitor the levels of eleven nutritional elements in the food supply and in the diets of eight age-sex groups. Of special concern are the low levels of calcium, magnesium, iron, zinc, copper, and manganese and elevated levels of sodium and iodine in the diets of selected age-sex groups. We anticipate the addition of two nutritional elements, molybdenum and nickel, to the Selected Minerals in Foods Survey in the near future.

Table 1

Results from the Selected Minerals in Foods Survey, 1974-82*

	adult male	6-month infant	2-year child
(% RDA)			
Ca	135-149	153-187	92-111
P	209-223	235-251	129-141
Mg	94-102	197-203	113-115
Fe	179-210	31-68	51-79
Zn	83-93	100-142	81-96
I	213-551	364-1152	230-1040
(comparison with ESADDI)			
Na	high+	high	high
K	OK	high	high
Cu	low	low	low
Mn	OK	high	OK
Se	OK	OK	OK

* Pennington, J.A.T., et al., J. Am. Diet. Assoc. 84(7):771-780, 1984.
\+ Includes discretionary salt.

Table 2

Results from the Selected Minerals in Food Survey, 1982/83 & 1983/84*

(% RDA)	Ca	P	Mg	Fe	Zn	I
6-11 mo f&m+	137	194	169	79	105	400
2 yr f&m	80	106	103	56	74	657
14-16 yr f	61	89	64	59	66	280
14-16 yr m	95	137	74	96	104	473
25-30 yr f	71	122	62	58	64	180
25-30 yr m	105	192	82	159	108	347
60-65 yr f	62	110	61	102	57	167
60-65 yr m	82	156	70	144	84	227

(comparison) with ESADDI)	Na	K	Cu	Mn	Se
6-11 mo f&m	OK	HIGH	LOW	HIGH	OK
2 yr f&m	HIGH	OK	LOW	OK	OK
14-16 yr f	OK	OK	LOW	LOW	OK
14-16 yr m	HIGH	OK	LOW	OK	OK
25-30 yr f	OK	OK	LOW	LOW	OK
25-30 yr m	OK	OK	LOW	OK	OK
60-65 yr f	OK	OK	LOW	LOW	OK
60-65 yr m	OK	OK	LOW	OK	OK

*Pennington, J.A.T., et al., J. Am. Diet. Assoc., in press, July 1986.
+ f = female; m = male.

DATABASE COMMITTEE REPORT

Loretta W. Hoover, Chair
University of Missouri-Columbia

The primary activity of the Database Committee has been compilation of the Nutrient Data Bank Directory. This document was first compiled in 1980 by Donna Hay and Tony Fisher and listed 28 data bases including those from USDA. Since that time the number of systems has increased and each subsequent edition has included more citations. In 1982, the 2nd Edition included 39 systems. In the 3rd Edition in 1983, 55 systems were described and citations for the USDA data bases were not included since information about USDA data bases has been made available directly from USDA to conference attendees and other interested parties. In 1984, the 4th Edition was expanded to include more information about the data bases and a new section was added to describe the features of the software used in the systems. For various reasons, a new edition was not produced in 1985; however, a supplement to the 4th Edition was prepared to provide updated information about systems described in the previous edition and to describe 18 new systems. This year the 5th Edition includes information for 99 systems and was expanded to include 39 fields of additional data.

One of the challenges encountered in this activity is assuring that the information is both correct and up-to-date. With each new edition, data base developers have been asked to revise information about their systems and to supply new information. For the 5th Edition, 84% of the developers provided updated information. Due to the perishable nature of the information in the Directory, we are very appreciative of the cooperation of the data base developers to assure that dependable information is reported.

In addition to distribution to attendees at the National Nutrient Data Bank Conferences, the Nutrient Data Bank Directory is available for purchase by the public to help cover some of the production expenses. Due to limited sales, recent editions have been underwritten by the University of Missouri-Columbia. This year we are pleased to acknowledge partial support for the 5th Edition from the International Network of Food Data Systems (INFOODS). Now that a total revision has been accomplished, we plan to market the directory and would appreciate any suggestions relative to suitable target groups.

Developers of nutrient data base systems have been surveyed since 1984 in an effort to identify their needs for data and their opinions about standardized coding schemes. Joanne Holden has compiled the responses to the survey and a summary of that information was presented at the INFOODS conference on Users and Needs in March, 1985.

Last year at the conference in San Francisco, the Database Committee was asked to join with the Guidelines Committee to explore the desirability of considering a process for establishing guidelines. After some deliberation, most agreed that the issue was too complex to address properly at the conference.

The committee welcomes suggestions regarding new activities that should be undertaken or ways that the committee can assist users of data bases.

EVALUATING NUTRIENT DATA BASES

Kim Crawford, Drexel University

1. INTRODUCTION:

A. General uses of a nutrient data bases:

1. The most common,use of a nutrient data base is to assess the nutrient level of the diet.
    a. diet history of a patient
    b. analyzing results of a nationwide food consumption survey
2. Research purposes
3. To do recipe calculations
4. To develop definitions for imitation foods and food substitutes
5. To develop regulatory policies for nutrient fortification and food additives
6. To determine the adequacy of the U.S food suppiy to meet nutritional needs
7. To plan or evaluate menus for school lunch programs, hospitals, and other institutions and feeding groups
8. To develop nutritional labeling
9. To construct exchange lists

B. Identify your specific needs for a nutrient data base

2. CHARACTERISTICS OF A NUTRIENT DATA BASE:

A. Types of FOODS:

1. Food variabiltiy ie. apples whole, applesauce
2. Food types vary depending on the intended use:
    a. Food Company may need only compositional data for its own food and perhaps for competitors food products.
    b. Hospital data base should include institutional, special, and medical foods used throughout the institution
    c. Data bases used for assessment of patient/client, or for epidemiological or nutritional studies should reflect the

general food supply and must include traditional, commercial(brand name food items), homemade, restaurant, and ethnic foods

B. Number of FOODS:

1. The number of foods is a function of the food descriptors- the greater the level of detail per food item the more foods you may need in the data base.
2. The number of foods in currently available data bases ranges from 57->15,000+
   a. FDA total diet study 234 foods
   b. DAS(Dietary Analysis and Assessment Systems) 1,000 foods
   c. DINE 3,500 foods
   d. OSU 8,700 foods
   e. COMPUTRITION 15,000+ foods
3. The number of foods in a data base should also reflect the unique nutritional differences of indivdual foods and the importance of these nutritional differences to the use of the data base.

C. Food Descriptions:

1. Range from general to very specific depending upon the use of the data base
   a. food consumption surveys- the level of detail should reflect the level of detail of the survey questionnaire
2. It may be important to know:
   a. the source of the food data
   b. preservation method
   c. type of packaging material
   d. the preparation method
   e. mixed dish
3. There should be a specific order for descriptive terms:
   a. For example alphabetical order
   b. BE CONSISTENT
4. If the data base contains descriptive terms, there should be a dictionary to explain the specific definitions of these terms.
   a. define low sodium
   b. define a cooking method

D. Classification or coding schemes:

1. Classifying and coding data should reflect the detail of data base.
2. Classification schemes:
   a. most common classification schemes are based on major food groups with minor subgroups in each food group
      -example: major food group: vegetables
      minor subgroup: beans
      - useful for diet evaluations, food consumption studies
   b. classification based on food descriptors:
      -product type
      -food source
      -degree of preparation
      -packaging material
      -ingredients

E. The nutrients to be included:

1. Selection of nutrients to include in the data base directly relates to the persons use of the data base.
   a. Institutional meal planning may only include RDA and dietary goal nutrients.
   b. Food industry may only include nutrients which pertain to food labeling or food items used in their products.
   c. Multi purpose data base is all inclusive.
      -leads to missing nutrient values since some foods have a lot of nutrient data available and other foods have only partial data available
2. Some nutrients included in the data base may have no current food records, but this allows for easy addition of the nutrient values as the data becomes available. It is more difficult to add new nutrients to an already existing data base.

F. Number of NUTRIENTS.

1. Decide exactly which nutrients are needed.
2. Currently available data bases contain between 4-100+ nutrients and may include:
   a. the 17 nutrients available in the old USDA Handbook #8
   b. those nutrients available in the revised Handbook #8

c. the lesser known vitamins and minerals as data becomes available
d. simple sugars, amino acids, and fatty acids

G. The expression of the nutrient values:
1. Nutrient values should be expressed on a fresh wet-weight basis.
a. a lot of literature reports nutrients values on a dry weight basis.
2. Nutrient values expressed per 100 grams of the food item.
a. most common way nutrient values are expressed
b. uses in food industry, research
3. Nutrient data expressed per single serving size.
a. uses for diet history, food consumption data- frequency use
4. Data that has been imputed or calculated from recipes should be documented or footnoted.
5. The units in which nutrient data is expressed varies:
a. Vit A IU or Vit A RE or Carotene
b. Energy- Calories or Joules

H. Addition information:
1. Food exchanges
2. Allergy codes such as gluten or lactose
3. Supplement class such as adult, child, or both

3. <u>SOURCES OF NUTRIENT DATA:</u>
A. The major source of the nutrient data
1. USDA Handbooks
2. USDA Home and Garden Bulletin
3. Data from food manufacture
B. The sources used to update the nutrient data
C. The policies that exist with regard to the updating
1. cost
2. how often will you receive the nutrient updates?
D. Addition of new foods
E. Addition of brand name food items
F. Addition of new nutrients

G. Missing nutrient values

H. Sources of nutrient data bank errors:

1. poor laboratory method
2. poor laboratory technician
3. random error
4. imputed values
5. coding errors

4. SELECTING SOFTWARE:

A. When evaluating a nutrient data base, compare the software packages that are compatible with the data base.

1. Does it meet your needs?
2. Make sure the software is compatible with the hardware
3. Features to be concerned with:
    a. computational options available such as: single day diet histories, multiple day diet histories, meal by meal analysis, food group assessments
    b. standards of assessing nutritional adequacy of diets RDA's or other standards such as dietary goals
    c. the way missing values are treated
    d. data entry method of foods
        -key entry
        -alphanumeric search
        -optical scan
        -making choices from a list on terminal screen
    e. coding process for data entry
4. Documentation:
    a. Appearance- format, print quality
    b. Usefulness- index, table of contents, clarity
    c. Completeness
    d. Writing style- jargon, academic or conversational

5. EVALUATING NUTRIENT DATA BASES:

A. Analyze specific needs for a nutrient data base

B. Review the characteristics of a nutrient data base

C. Investigate the sources of nutrient data

D. Evaluate compatible software packages

NUTRITION EDUCATION SOFTWARE

Patricia F. Plummer M.Ed., R.D.
Framingham State College, Framingham, MA

Framingham State College has recently conducted several projects involving the application of nutrition software for microcomputers. The one I will discuss is an evaluation of nutrition education software for use in public schools. This project was funded under the Nutrition Education and Training Program through the Bureau of Nutrition Education and School Food Services of the Commonwealth of Massachusetts Department of Education. The project has involved faculty and senior nutrition majors at Framingham State College and elementary, middle and high school teachers and students in the Framingham Public Schools and two other local school systems.

The purpose of the project is to provide public school teachers and nutrition educators with a resource guide to selecting nutrition education software. Educators are faced with limited budgets for software and limited information on which to base their choices. Most software producers do not permit preview of their programs nor can the software be returned if the buyer is dissatisfied with the content. These policies protect the producer from unauthorized copying but they also impede the process of providing accurate and useful nutrition education software in the classroom.

Computers have a great deal of potential in nutrition education. Nutrition is a multidisciplinary subject area and as a result may be taught as part of a number of different courses in schools. Nutrition is included in general science, biology, chemistry, health education, physical education, and home economics. It would be unusual for a teacher in any of these subject area to have more than one if any college courses in nutrition. As a result the teachers have a varied and often limited knowledge of nutrition subject matter. The computer can be very helpful in increasing the accuracy of nutrition content in these courses. The computer can also provide more depth of nutrition information than is usually available in schools by calculating individual Recommended Dietary Allowances, activity levels and dietary information. This, of course, depends on the accuracy of the programs. It is very difficult for teachers to evaluate accuracy although they are very good evaluators of the instructional value of software. In this project, nutrition professionals evaluate the scientific accuracy of the programs and the teachers and their students help us evaluate the educational value of the software.

Approximately forty pieces of software are being evaluated for the accuracy of their nutrition content and their usefulness as a teaching tool. The evaluation form used is the "Microcomputer Software Evaluation Instrument" published by the National Science Teachers Association. This instrument meets the need for evaluating software that might be used in a number of subjects areas. This instrument was selected in part because it provided an option for adding criteria for specific nutrition content Each piece of software is first evaluated for scientific accuracy by faculty and senior year majors in nutrition. The nutrition students conduct the evaluations as part of the requirements in the course "Computer Applications in Dietetics". These students have been able to detect a number of inaccuracies, discrepancies and misleading statements that might not be recognized by classroom teachers. The software being evaluated is limited to those programs with nutrition education content. Programs that provide only nutrient analysis have been evaluated in a previous project by Dr. Charlene Hamilton of Framingham State College.

Software that meets a minimum standard for accuracy, set at six out of a possible ten points, is then evaluated for classroom use. Up to this time these evaluations have been conducted in two ways, teacher evaluations during workshops and teacher evaluations during actual classroom use. At the elementary level software has been made available to teachers during inservice workshops on software evaluation conducted by the Framingham Public School System. These workshops are provided for teachers so that they may become familiar with a variety of types of educational software. The Framingham Public Schools use computers extensively in the classroom and teachers are experienced and critical evaluators of software. Nutrition students were available during these evaluation workshops to assist the teachers. Some software for elementary school was also evaluated with students but this was limited to schools that had computer laboratories where a number of students could work at one time.

At the middle school level (sixth, seventh and eighth grades) software was evaluated in the classroom by teachers and students. A nutrition student or faculty member participated in the presentation and evaluation of the software in the classroom. All but one of the evaluations in the middle school took place in a home economics course. One evaluation was part of a sixth grade general science program. The input of the middle school students in these evaluations was very helpful.

At the high school level software was evaluated by teachers and students as part of a food and nutrition course. The teacher in the course holds a master of science degree in nutrition and computers are used extensively in the course.

The teacher and the students wrote detailed evaluations and they were able to make useful comparisons of software with similar content.

We are finding that the quality of nutrition education software varies a great deal. This is true of educational software in general. Software is often poorly designed and difficult to use. Unfortunately poor software discourages computer use by both teachers and students. Software production is a very fast growing business. Often good computer programmers lack knowledge of educational principles and the content area and may produce programs that do not fit into the curriculum or the educational philosophy of the teacher. On the other hand, educators who write programs that have a good instructional basis may be so unsophisticated at programming that their software may have little motivational value and may not utilize the unique educational capabilities of the computer.

The computer offers some unique educational advantages. For example, immediate feedback can be given on both correct and incorrect responses to questions. A management system can be programmed to provide the teacher with a record of students' progress on the computer. Tutorials can be used that can branch to different information depending on the students skill level determined by responses to questions. The computer is infinitely patient and can therefore provide drill and practice for as long as necessary. Animated graphics can be motivational and a good teaching aid. However, the use of integrated computer and videotape instruction will probably improve on animated graphics. The computer is particularly well suited for carrying out tedious calculations inherent in dietary and energy analysis.

The value of the computer as a teaching tool is limited, however, by the quality of the software. Some software is written to be no more than an electronic textbook or "page turner". The student reads information off the screen and does little more than press a key occasionally. This type of program is a poor use of computer time. Another problem with reading from the screen occurs when the reading level required is higher than the grade level of the content area. We found several programs that had nutrition content typical of lower elementary grades but required a fifth or sixth grade reading ability. Some programs require fairly advanced keyboarding or typing skills. Words need to be typed and spelled correctly,a time consuming and frustrating task for some students. This happens particularly in programs that seem to focus on extraneous skills like word scrambles and crossword puzzles. There are several program design factors that make a program either "user friendly" or frustrating. The program must allow correction for errors in typing, it should not "crash when an incorrect key is inadvertently pressed and it should allow the user to exit a portion of the program without rebooting.

Nutrition educators have an important challenge in improving the quality of nutrition education software. Nutrition content in school curricula is fragmented partly because it crosses many subject areas. Teachers do not have clear guidelines for appropriate nutrition content at each grade level. While most subject areas have an accepted scope and sequence throughout the grade levels, nutrition units tend to have the same information repeated year after year and many important areas not included at all. This curriculum problem is very evident in nutrition software. For example, software appropriate for second graders focuses on understanding the five food groups, placing foods appropriately in the groups and evaluating a days diet based on food groups. This same type of activity is repeated at every grade level including twelfth grade in some of our software. It would seem logical to develop some type of sequence that would recommend evaluation by food groups through fourth or fifth grade, then move on to a focus on nutrients and nutrient needs and issues in nutrition and health.

In conclusion, computers have great potential in nutrition education. This potential is limited by the accuracy and appropriatness of the nutrition content and the quality of the programming. Nutrition educators need to become actively involved in the development of excellent nutrition education programs.

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Patricia F. Plummer M.Ed.,R.D.

Nutrition Education Software Evaluation Project

Software List

Daily Menu Analyzer	Orange Juice Software Systems	$145.00
Disappearing Dinner	Marshware	$24.95
Eat for Health	Genesee Int.School District	$40.00
Fast Food Micro-Guide	The Learning Seed	$49.00
Fatjack	The Learning Seed	$49.00
Food and Fitness	University of Idaho	$10.00
Food Encounters	National Dairy Council	$40.00
Food Facts Fun	Scott, Foresman	$49.95
Food for Thought	Dietary Data Analysis	$39,95
Food for Thought	Marshware	$39.95
Food Group Puzzles	Marshware	$39.95
Grab a Byte	National Dairy Council	$40.00
Grease	Dietary Data Analysis	$27.95
Heart Anatomy and Physiology	American Heart Association	$9.00
Home Food Storage	University of Idaho	$10.00
Jumping Jack Flash	Dietary Data Analysis	$34.95
Menucalc	The Learning Seed	$39.00
Munchies	Dietary Data Analysis	$34.95
Nuti-Bytes	Center for Science in the Public Interest	$29.95
Nutraraid/Nutrapuzzle	Dairy,Food and Nutrition Council	$30.00

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Software List Continued

Nutri-Venture	Kellogg Company	$25.00
Nutrient Data Bank	The Learning Seed	$49.00
Nutrition a Balanced Diet	Educational Materials & Equip.	$39.00
Nutrition Express	Center for Sci.in Pub. Inter.	$39.95
Nutrition Pursuit	The Learning Seed	$49.00
Nutrition Simulation	EMC Publishing	$89.00
Nutrition Tutorial	EMC Publishing	$89.00
Nutrition Vol 1	MECC	$49.00
Nutrition Vol 2	MECC	$49.00
Nutrition/Game Format Study Aid	Orange Juice Software Systems	$45.00
RISKO	University of Idaho	$10.00
Salt and You	MECC	$39.00
Salty dog	Dietary Data Analysis	$27.95
Snackmonster	The Learning Seed	$49.00
Sweet Tooth	Dietary Data	$27.95
The Salt Shaker	The Learning Seed	$49.00
To Salt or Not to Salt	Orange Juice Software Systems	$110.00
Understanding Food Labels	The Learning Seed	$49.00
Vegetarianism	Julie Grannell	$20.00
Weightcalc	The Learning Seed	$49.00
What I Usually Eat	National Dairy Council	$20.00
What's in Your Lunch	Lawrence Hall of Science	$24.95
You Are What You Eat	Marshware	$39.95

REFERENCES AND RESOURCES

Loretta W. Hoover
University of Missouri-Columbia

GENERAL INFORMATION

Proceedings of the National Nutrient Data Bank Conferences. (See attached sheet of editors.)

Beal, V.A. and Laus, M.J., Eds.: Proceedings of the Symposium on Dietary Data Collection, Analysis, and Significance. Sponsored by the Department of Food Science and Nutrition (June 15-16, 1981). Research Bulletin Number 675, Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst, 1982. 164 pp.

Youngwirth, J.: The evolution of computers in dietetics: A review. J Am Diet Assoc 82:62-67, 1983.

Hoover, L.W.: Computers in Nutrition, Dietetics and Foodservice Management: A Bibliography. 3rd Ed. Columbia, MO: University of Missouri-Columbia Printing Services, 1985. 45 pp.

Hertzler, A.A. and Hoover, L.W.: Review of nutrient data bases: Development of food tables and use with computers. J Am Diet Assoc 70:20-31, 1977.

Willard, R.: Computers in dietetics. Dietetic Currents 9(3):7-14 (May/June), 1982.

DIRECTORIES

Hoover, L.W., (Ed.): Nutrient Data Bank Directory. 5th Ed. Columbia, MO: University of Missouri-Columbia Printing Services, 1986. 73 pp.

Hilderbrandt, Darlene Meyers: Computer Programs and Databases in the Field of Nutrition. 4th Edition. Seattle, WA: Computing Information Center, UW ACC, HG-45, University of Washington, 1985. 30 pp.

Computers in Nutrition Education. Theme Issue of the Journal of Nutrition Education, Volume 16, Number 2, Summer, June 1984. Order from: Subscription Department, Society for Nutrition Education, 1736 Franklin Street, Oakland, CA 94612.

Journal for Dietetic Software, P.O. Box 2565, Norman, OK 73070.

Computer Software for Nutrition and Food Education. Contact: Nutrition Information and Resource Center, College of Human Development, Pennsylvania State University, Benedict House, University Park, Pennsylvania 16802.

Frank, Robyn: Directory of Food and Nutrition Information Services and Resources, published by ORYX Press.

International Directory of Food Composition Tables. Compiled by: International Network of Food Data Systems, Room 20A-226, Massachusetts Institute of Technology, Cambridge, MA 02139, USA. 15 pp.

U.S. GOVERNMENT SOURCE OF NUTRIENT DATA

United States Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Sales Desk: (703) 487-4650.

SYSTEM REVIEW TOOL

Hoover, L.W. and Perloff, B.P.: Model for Review of Nutrient Data Base System Capabilities. 2nd Ed. Columbia, MO: University of Missouri-Columbia Printing Services, 1984. 78 pp.

MISSING DATA

Posati, L.: Procedures for imputing values. Proceedings of the 10th National Nutrient Data Bank Conference. Springfield, VA: National Technical Information Services, U.S. Department of Commerce, 1985. p. 124-133.

Journal of Food Composition and Analysis -- Publication to begin in early 1987. Sponsored by International Network of Food Data Systems (INFOODS).

Periodical literature such as Journal of the American Dietetic Association, Journal of Food Science, Cereal Chemistry, Journal of the American Oil Chemists Society, and Cereal Foods World

RECIPE CODING RESOURCES

Adams, C.F. and Fincher, L.J.: Procedures for Calculating Nutritive Values of Home-prepared Foods: As Used in Agriculture Handbook No. 8, Composition of Foods--Raw, Processed, Prepared, Revised 1963. U.S. Department of Agriculture, ARS 62-13, 1966.

Provisional Table on Percent Retention of Nutrients in Food Preparation. U.S. Department of Agriculture Nutrient Data Research Group, October 1982. 2 pp.

Matthews, R.H. and Garrison, J.J.: Food yields summarized by different stages of preparation. U.S. Department of Agriculture, Agriculture Handbook No. 102 (Rev.), 1975.

Adams, C.F.: Nutritive Values of American Foods in Common Units. Agriculture Handbook No. 456, Agricultural Research Service, U.S. Department of Agriculture, 1975.

Andrews, J.T.: Development of a standardized recipe data file for computer systems. In: Moore, A.N. and Tuthill, B.H. (Eds.): Computer Assisted Food Management Systems, pp. 33-45. Columbia, MO: University of Missouri Technical Education Services, 1971.

Marsh, A.: Problems associated with recipe analysis. In: Toblemann, R., (Ed).: Proceedings of the Eighth National Nutrient Data Bank Conference. Washington, D.C.: U.S. Department of Commerce National Technical Information Service, July, 1983. pp. 29-38.

Perloff, B.: Recipe Calculations for the NFCS Data Base. Proceedings of the 10th National Nutrient Data Bank Conference. Springfield, VA: National Technical Information Services, U.S. Department of Commerce, 1985. p. 11-21.

Powers, P.: Recipe Calculations -- New Research in Methodologies. Proceedings of the 11th National Nutrient Data Bank Conference, University of Georgia, 1986. (In Press)

HANDS-ON USE OF SOFTWARE

USDA Food and Nutrition Information Center located at the National Agriculture Library, Beltsville, MD 20705

INFOODS: A 1986 STATUS REPORT

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INTRODUCTION

INFOODS stands for "International Network of Food Data Systems". It was put together a few years ago to serve as a focal point for those who are, or should be, interested in what is in the foods we consume. Its goal is to focus attention and effort on improving the quantity, quality, and accessability of food composition data.

In terms of the future, INFOODS is trying to create an environment -- in essence, the essential machinery -- so that anyone, anywhere in the world, can ask questions about what is in foods and get reasonable answers in a reasonable length of time. What we are working towards is the time when someone can write a letter, pick up a telephone, or sit down at a terminal and make a request for some aspect of food composition data and get a satisfactory response. In order to give this rather lofty goal more substance, let us consider some of the questions that might be asked (and indeed are asked now). This, unfortunately, leads directly into consideration of some of the problems with the current situation.

NEEDS FOR FOOD COMPOSITION DATA

For a start, the basic questions are those relating foods and nutrients. Someone wants to know what nutrients are in specific foods, or what foods contain what nutrients. For example one might want to know what is in fruit, and desire a matrix of data; or what is in a specific fruit, for example, an apple, and consider a row of data a satisfactory answer. Alternately, one might focus on a single nutrient, wanting to know the vitamin A content of fruit, or quite specifically, the vitamin A content of an apple.

Parallel to these questions are those essentially going the other way -- wanting to know, for example, a good source of vitamin A or what foods someone with a specific metabolic disorder should avoid, or what foods would make up an interesting, nutritious diet.

Beyond these fairly straighforward questions lie a host of more complex ones, which require data beyond what foods have what nutrients. [See Figure 1.]

Figure 1

FOODS <------------> NUTRIENTS

other data:

CONSUMPTION
REQUIREMENTS
AVAILABILITY
COST
RECIPES
PROCESSING AND PREPARATION
DISEASE PATTERNS
BIOLOGICAL ACTIVITY

Foods, being at the very foundation of our existance, are involved with an incredibly varied spectrum of interesting questions.

There are questions about consumption and requirement:

How do people in Keyna consume their iron requirement?

What foods consumed in the Far East are made from peanuts?

There are questions about the cost and availability of foods:

Are there good local substitutes for the wheat that so many countries import?

What foods on the international market could reasonably be fortified with vitamin A?

Then there are the questions that ask about how foods are prepared and processed:

What fried foods are consumed in Peru?

What foods in India are prepared in copper vessels?

Finally, there are those questions that require information on the geographic patterns of disease, or on the biological interactions between foods, nutrients, and other components of foods:

> Is there any correlation between fish oil consumption and atherosclerosis?
>
> Are any foods/components that are consumed in Latin America correlated with the incidence of gastric cancer?

This list, of course, could go on and on, in fact one of the problems that we continually face is that the questions are really more interesting than the data. I think that this is one of the reasons that the data have often been neglected. Of these questions, good data simply do not exist for many, and even where there are data our problems are not over. Let me consider what appears to be a simple question in a little more detail. [See Table 1.]

Table 1

HOW MUCH VITAMIN A IS IN AN APPLE?

US	5	RE	VITAMIN A
	53	IU	VITAMIN A
UK	0	MCG	RETINOL
	23	MCG	CAROTENE
GERMANY	0.000	MCG	VITAMINE A
	0.047	MG	CAROTENE
INDIA	0	MCG	CAROTENE
CHINA	.08,.4	MG	CAROTENE
JAPAN	0	MCG	RETINOL
	11	MCG	CAROTENE
	0	IU	RETINOL POTENCY
KOREA	10	IU	
LATIN AMERICA	10	MCG	VITAMIN A

"How much vitamin A is in an apple?" seems innocuous enough, however, if you are taking an international view, and go to specific country tables, you find that things are not at all straightforward. Different tables have different numbers. The next logical step is to ask why? Since there are two components of this simple question -- the food and the nutrient, we can break the question into two parts: what is an apple and what is vitamin A.

Table 2 shows one aspect of this -- and I chose apple as an example because I thought that it would be well-defined, given that you can move beyond wanting to know what is in the apple you ate yesterday, or the one you may eat tomorrow.

Table 2

WHAT IS AN APPLE?

USA	MALUS SYLVESTRIS
UK	MALUS PUMILA
GERMANY	PIRUS MALUS
INDIA	MALUS SYLVESTRIS
CHINA	MALUS PUMILA, M. DOMESTICA, M. DASYPHYLLA, M. COMMUNIS
	PYRUS MALUS
KOREA	MALUS PUMILA
LATIN AMERICA	MALUS SYLVESTRIS
CODEX ALIMENTARIUS (FAO/WHO)	MALUS DOMESTICUS

If you are interested in the vitamin A content of a generic apple you might want to look at how each table defines "apple". At first glance it would seem that the differences between the tabled entries might follow from the fact that each is looking at something different, even different genera, although all are called "apple". However, if you go into things a bit more deeply, you find that probably these are all the same species at least, the differing names reflecting taxonomic battles over priorities rather that real differences. Of course, there are most probably very great differences between the apples that were analyzed, depending on variety or cultivar and where and how grown, but the point I would like to emphasize is that the tables have introduced a new confusion into all this, probably quite independent of the data, and moreover, few give any information that would really help the user sort out why the data differ.

I could have prepared a similar table about what is vitamin A -- for example pointing out that many tables use 1/6 to convert from beta-carotene to retinol equivalents, while, at least in India, 1/4 is used, but this gets very complicated. So, to move from the particular to the general, considering the whole area of food composition data, Table 3 shows six major problem areas that INFOODS has identified at the moment.

Table 3

FOOD COMPOSITION DATA - PROBLEM AREAS

1. GETTING MORE AND BETTER DATA
2. CATALOGUING EXISTING DATA
3. DESCRIBING AND IDENTIFYING DATA
4. CONNECTING DATA AND USERS
5. LINKING TO OTHER DATA
6. USING THE DATA

PROBLEMS OF FOOD COMPOSITION DATA

First is the fact that we need more and better data. There are large gaps in our knowledge of what is in the foods that are consumed around the world. And also, we need much better information about how these foods and nutrients interact.

Second, we need better information on exactly what data do exist, where they are, and how good they are.

Third, we need a scheme for unambiguiously identifying and describing foods and the components of foods, as well as the data themselves.

Fourth, there needs to be some way of easily connecting the users with the data. Free enterprise is a wonderful institution, however, the software vendors have not really addressed the overall problem, and certainly not in the global context.

Fifth, we need to be able to link, and again easily, food data to other data sets, from consumption to costs. It is a real bother to have to solve the linkage problems anew each time anyone wants to do something.

And, sixth, as this group knows especially well, there are problems in the use of the data that do exist. Not, of course, that any of us would misuse data, but there are others. I happen to feel, on good days, that many of these problems stem from the other five problems, from the lack of appropriate data, or the difficulty of getting the right data.

ACTIVITIES OF INFOODS

In the area of data quality we are sponsoring the English chemist, David Southgate, in his production of a manual on the gathering of food composition data. We are trying to work with Wayne Wolfe, of the USDA, on developing some global scheme for food reference standards. We have worked out an arrangement with the United Nations University whereby it is now giving INFOODS fellowships to permit developing countries to send people for training in food analysis. Building on these activities we are starting to think about developing short courses on food analysis that can travel to parts of the developing world. In terms of the data that get into tables, one big area that we are trying to get organized now is how non-analytic data are estimated -- we are trying to codify methods of calculation and imputation.

In the area of nomenclature and terminology we have a task force, run by Stewart Truswell of Australia, that is developing a scheme for global food and data identification. As I indicated earlier, this is not a simple problem -- the first thing that must be realized that there is a critical distinction between the data and the food from which they come. Once you have defined an apple, you need to define what apple or apples were analysed, and how, and what happened to the data then. These data about the data can be called "metadata", and we are slowly moving into trying to set out some ground rules for these -- how does one define and measure data quality, for example, and how do you communicate to the user information on how well certain data might fit in with their needs.

The area of access to the data is being coordinated, and to a large extent done, by John Klensin of MIT, who is here today and will talk more to this topic this afternoon. Our directory of food composition data tables, an international counterpart to Loretta Hoover's one for the United States, is now in its first edition, and currently being revised and expanded. We have produced a scheme for interchanging data between different parts of the world. In a cooperative project with USDA, we are currently embarked on a exploration of how existing computer networks can be used to communicate betweeen individuals and groups in the field.

One of our next big projects is the design of a regional data center, where we are preparing to give advice to various groupings of developing countries as to how they can organize their resources to improve their food composition data situation.

The other major activity that we are trying to accomplish is that of linking together people in the field. Within the US there is this conference; however, little exists internationally. We have a very small secretariat where we try to coordinate things, with varying degrees of success. We put out a newsletter to tell everyone what we are doing. Early next year we will start an international Journal of Food Composition and Analysis with Kent Stewart of VPI as editor, publishing scientific articles covering the whole field from food analysis to data manipulation to usage.

Additionally, we are trying, again with varying degrees of success, to get the world split up into geographic regions of managable size, and within each region to get an organization set up to deal with food composition data. We have forged links with two existing groups -- EUROFOODS, based in Holland, and NORFOODS, based in Upsalla, and we are working hard now on getting an ASIAFOODS and a LATINFOODS going. We have plans to talk to some of the countries in Eastern Europe this fall and there are indications that the countries of the South Pacific may be gathering together to work on the problems of their area. In the future are plans for Africa and the Middle and Near East, but things are more difficult there.

This briefly surveys what INFOODS is all about, and I hope gives you some feel for its whats and whys. While our stated focus is international, this is misleading in that the problems that we are trying to deal with are the problems that exist in the United States. Our basic tenent is that because food and disease are growing more and more international, the problems of food composition data must be considered in their global context.

SELENIUM IN THE AMERICAN FOOD SUPPLY

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The Se contents of human foods vary widely due to such factors as the species, the particular variety or cultivar, the methods of preparation and/or processing, the climatic conditions during the growing season, and the amount of biologically available Se in the particular environment (e.g., the soluble Se content of the soil for plant species, the biologically available Se content of the diet for animal species). Of these factors, the most important by far in determining the Se contents of foods and feeds is the last. Due to the intimate relationship between plants and animals in food chains, the Se contents of foods from both plant and animal origins tend to be greatly influenced by the local soil Se environment. Thus, all types of foods tend to show strong geographic patterns of variation in Se content, reflecting in general the local soil Se conditions. Within the United States the Se contents of locally produced foods in the relatively high-Se area of the Dakotas are substantially greater than those of comparable foods produced in the relatively low-Se areas of Ohio and Indiana. Two countries, Finland and New Zealand, with local experiences with Se-deficiency syndromes in livestock, have foods with even lower Se contents. On a global basis, foods with the lowest Se contents have been found in the low-Se regions of China, in particular, the provinces of Heilongjiang, northern Shaanxi and Sichuan. Ironically, high seleniferous foods have also been found in China, in two areas of endemic selenosis of animals and people in Enshi County, Hubei Province and in Ziyang County, Shaanxi Province.

1. Analysis of Se in Foods

The analysis of Se can be accomplished by a variety of techniques some of which are applicable to foods (see Table 1). Of these procedures, the fluorometric method using diaminonapthalene (DAN) has been the most poplar. This method involves oxidation of sample selenium to Se^{+4}, and reaction of the DAN to form benzopiazselenol which fluoresces intensely at 520nm when excited at 390 nm and which, thus, can be quantified using a fluorometer. The chief advantages of the DAN procedure are its good sensitivity (ca. 0.002 ppm in foods) and its relatively low cost. However, the method is laborious and has two potential pitfalls which must be avoided.

The first involves the loss of Se during the acid digestion of samples containing large amounts of organic matter. Adequate acid digestion of Se in biological materials requires the complete conversion of the native forms of the mineral to Se^{+4} and/or Se^{+6} and the subsequent reduction of any Se^{+6} formed in the process to Se^{+4} without loss of total Se. Inorganic Se can be volatilized under the conditions of acidic digestion in the presence of such large amounts of organic materials that charring occurs, especially when sulfuric acid is used as an oxidant. The release of volatiled Se, probably in the form of H_2Se, can result in significant errors in the analysis of fatty materials, such as egg yolks or fatty meats. Because Se is volatilized from acid solutions by reducing agents, this loss can be avoided by maintaining strongly oxidizing conditions during digestion and by using low heat such that the oxidation of Se^{+4} to Se^{+6} proceeds relatively slowly. This can be achieved by raising gradually the temperature of the perchloric acid solution to 210°C. When the nitric-perchloric acid digestion is controlled and carefully attended, it produces satisfactory conversion to Se^{+4} even of such forms as trimethylselenonium ion (a major urinary metabolite) which are resistant to oxidation by nitric acid alone. Comparisons of the nitric-perchloric digestion method with direct combustion in an oxygen environment have shown that both yield comparable results.

The second potential problem involves interference due to fluorescent degradation products of DAN itself. This can be avoided by purifying the DAN reagent by recrystallization from water in the presence of sodium sulfite and activated charcoal, or by stabilizing it with HCL and extraction with hexane. Several investigators have incorporated these procedures into methods using DAN which are convenient for use in the routine analysis of Se in biological materials.

Conventional atomic absorption spectroscopy (AAS) has not been suitable for the determination of Se in foods due to the generally high limit of detection (ca 0.1 pp.) by that procedure. Variant AAS methods, however, have been developed with sensitivities adequate for biological use. One such method involves hydride generation of sample Se followed by quantitative detection by AAS. This method requires only small sample sizes (e.g., 0.1g), has adequate sensitivity (ca. 0.01 ppm), and the hydride generation step has been automated. However, it suffers from possible interferences due to other elements that can form hydrides (e.g., Cu, As, Sb). Of these, the most serious interference is due to Cu; steps must be taken to remove Cu by the use of HCL, tellurite or thiourea.

Better sensitivity has been obtained using electrothermal AAS. This method avoids the problems associated with wet digestion by employing high temperature oxidation in a graphite furnace. Use of a high temperature (e.g., atomization at 2400°C) reduces interferences due to nonspecific absorption of organic compounds and non-Se salts, but introduces the problem of volatility of Se under such conditions. This problem can be avoided by the use of salts for thermal stabilization. In practice, electrothermal

AAS has sensitivity for Se at ca. 0.003 ppm; with the use of a Zeeman-effect background correction system, sensitivities approaching 0.001 ppm have been reported.

Plasma atomic emission spectrometry (PAES) has not been used widely for the analysis of Se in biological materials. Although very good sensitivity (ca. 0.001 ppm) has been reported using inductively coupled PAES, matrix effects present such a great amount of interference that most laboratories are not able to obtain reasonable sensitivity by this method. Direct current PAES has not had adequate sensitivity for biological use.

Instrumental neutron activation analysis of Se offers the advantages of applicability to small sample sizes and relative ease of sample preparation. Although the greatest sensitivity (ca. 0.02 ppm) by this method is obtained by measuring ^{75}Se, its use necessitates lengthy irradiation (100 hrs), and long periods of post-irradiation holding (60 days) and counting (2 hrs). Greater economy with increased sample throughput has been achieved, at the expense of sensitivity, by the use of the short-lived (17.38 sec half-life) ^{77}Se, This isotope can be irradiated (5 sec), decayed (15 sec) and counted (25 sec) very quickly in an automated system. Due to the ease of this procedure as well as to its non-destructive nature, some investigators with access to research reactors have found instrumental neutron activation analysis useful for the measurement of Se. Nevertheless, the utility of the "fast" method is limited at the present time by its relatively low sensitivity, rendering it unsuitable for accurate quantitation of low concentrations of Se in many foods.

The measurement of Se by proton-induced x-ray emission (PIXE), offers the potential advantage of simultaneous elemental analysis of biological materials. This method involves proton bombardment of target atoms (the sample) to cause loss of inner shell electrons and their consequent replacement by electrons from the outer shell. The x-rays emitted during that transition are characteristic of the energy differences between electron shells and are, therefore, identifiable and quantifiable. At the present time, the sensitivity of this procedure for the determination of Se (ca. 0.01 ppm) makes it useful for many biological purposes, especially when simultaneous elemental analysis may be needed; however, it is not sensitive enough for the accurate determination of very low levels.

X-ray Florescence spectrometry offers another non-destructive technique for multi-element analysis; however, its sensitivity for Se does not compare favorably with other methods available for biological use.

A procedure for determining Se by double isotope dilution has been developed.[1] This method involves the use of two stable isotopes of Se as tracer (^{76}Se). Samples spiked with a known quantity of the internal standard are digested in nitric-phosphoric acid, undigested lipids are removed with chloroform, and hydrochloric acid is used to reduce any Se^{+6} to Se^{+4}. Selenite is reacted with 4-nitro-o-phenylenediamine to form 5-nitropiazselenol, and the nitropiazselenonium ion cluster is determined by combined gas-liquid chromatography/mass spectrometry. The native Se in the sample is calculated from the measured isotope ratios, using the ^{80}Se naturally present in the sample. Reamer and Veillon[1] have carefully developed this technique and have reported a sensitivity of less than 0.001 ppm. Their method employs a rapid digestion which avoids several of the problems associated with the use of perchloric acid, and is capable of fully oxidizing the often problematic trimethylselenonium. It thus appears to be suitable for biologic measurements and has been put to such use already.

A recent IUPAC interlaboratory (12 sites) comparison of the more widely used methods for the determination of Se in clinical materials[2] found statistically significant differences among the mean concentrations reported for Se in lyophilized human serum analyzed by either a) acid-digestion/DAN-fluorometry, b) electrothermal AAS, c) acid-digestion/hydride generation AAS, or d) acid-digestion/isotope dilution mass spectrometry, with slightly higher values reported by the first procedure. The four methods compared very favorably for the analysis of pooled lyophilized urine samples. However, only the fluorometric method showed homogeneity of variance among laboratories.

2. Se Contents of Foods

The published information concerning the Se contents of foods from several countries has recently been compiled[3]. Table 2 presents typical Se contents of American foods based upon those collected analytical results. The Se contents of prepared liquid in infant formulas[4,5] and solid infant foods[6] have also been reported. The Se contents of the latter use correlate with those of the corresponding foods. Prepared liquid formulas based upon meat or casein contain approximately an order of magnitude more Se (i.e., 0.073 ppm, fresh weight basis) than those based on milk or soy protein (i.e., 0.011 ppm, fresh weight basis).

The Se contents of several medical food supplements and tube feeding formulas were determined by Zabel et al[4] who found differences in the Se contents of casein hydrolysate-based solutions used for total parenteral nutrition (TPN) and TPN solutions based on mixtures of recrystallized amino acids. Whereas the latter type provided less than 5 ug Se per 1000 kcal of diet, the former type provided at least three times that amount and as much as 95 ug Se per 1000 kcal by virtue of the Se inherent in casein.

3. Sources of Variation in the Selenium Contents of Foods

Much of the variation in the Se content of foods is due to large scale geographical differences in environmental Se. Such variation is readily seen in comparisons of the Se contents of like foods from different countries. For example, whole wheat grain may contain more than 2 ppm Se (air-dry basis) if produced in the Dakotas,[7] but as little as 0.11 ppm Se if produced in New Zealand,[8] and only 0.005 ppm Se if produced in Shaanxi Province, China.[9] The geographic variation in the Se contents of several different foods produced with similar technologies in the US is shown in Table 3.

The Se contents of foods of plant origin can vary according to climatic conditions during the growing season which may affect crop yield, maturity at harvest, etc. For this reason, annual variations are to be expected in the Se contents of such foods as the cereal grains, with those of grains produced in high-yield seasons to be somewhat lower than those of grains produced in low-yield ones. This effect was apparent in the report of Varo et al.,[10] who found that the Se contents of wheat, rye, barley and oats produced in Finland were low in 1975, which had an exceptionally favorable growing season and good harvesting conditions. This combination of conditions resulted in the production of mature grain with relatively high starch content, but with Se (and other mineral) contents that were only about two-thirds of those of the previous year in which only average yields were realized. In contrast, grains produced in Finland in 1973 were generally higher in Se content due to conditions which resulted in relatively low yields during that year.

The Se contents of foods of animal origin depend, in large part, on the Se intakes of livestock. Food animals raised in regions with feeds of low-Se contents will, thus, deposit relatively low concentrations of the mineral in their edible tissues and products (e.g., milk, eggs); while animals raised with relatively high Se nutriture will produce foods with much greater Se concentrations. Due to the needs of livestock for Se to prevent debilitating deficiency syndromes, Se (usually as sodium selenite) is used as a nutritional supplement in animal agriculture in many parts of the world. This practice, which has become widespread in North America and Europe only within the last 10-15 years, has had the effect of reducing what would otherwise be strong geographic variation in the Se contents of animal food products over many different parts of the world.

In general, increases in dietary Se produce increases in the Se contents of animal meats, milk and eggs (Table 4). However, this relationship, while direct, is not linear. Within the ranges of normal levels of Se intakes, muscle meats from most species tend to plateau in Se concentration at 0.3-0.4 ppm (fresh weight basis). Organ meats usually accumulate greater concentrations of Se; the livers of several species have been found to accumulate about four times as much Se as skeletal muscle, and the kidneys of steers, lambs and swine have been found to accumulate 10-16 times the amounts in muscle. Poultry do not accumulate such great renal concentrations of Se; kidneys from young broiler chickens and turkey poults average only 4.9 and 1.4 times, respectively, those of muscle. Because of the property of most species to accumulate relatively great concentrations of Se in liver and kidney, food made from these organ meats tend to be rich sources of Se in human diets.

Varietal differences can be the sources of significant variation in the Se contents of some plant species. Although there have been few extensive varietal comparisons of Se content, the work of Wauchope[11] has nicely demonstrated the phenomenon in the case of soybeans. He compared the Se contents of 18 varieties of soybeans grown on adjacent plots either in Ames, Iowa, or in Stoneville, Mississippi. (Figure 1). The six varieties grown in Iowa varied in Se content by 600% (i.e., 0.08-0.48 ppm, air-dry weight). The 12 varieties in Mississippi varied in Se content by ca. 550% when grown in clay soil, and by ca. 145% when grown in loamy soil. The significant interactive effect of variety and soil type shows that varietal differences in the Se contents of foods of plant origin can vary between different geographic regions according to the local agronomic conditions.

The processing of cereal grains and oil seeds can produce food products with Se concentrations less than those of the parent materials due to the removal of relatively Se-rich components. For example, in soybean Se, which is associated with the protein fraction, is increased almost two-fold in the processing of isolated soy protein. In general, the germ and outer layers of cereal kernels are richer in Se than the endosperm. Therefore, milling products based on germ, bran and shorts (e.g., wheat screenings, corn mill germ, rice bran) tend to contain higher levels of Se than the parent whole grains; products based primarily on endosperm (e.g., wheat patent flour, corn flour, polished rice) tend to contain lower levels of Se than the parent whole grains. Nevertheless, the reductions in Se concentrations due to milling of cereal grains are generally only of low magnitude inasmuch as the differences in Se content of the various fractions of the kernel tend to be small. For example, Ferretti and Levander[12] found that the Se contents of wheat flour, white corn flour, yellow corn flcur and polished rice were approximately 87%, 86%, 79%, and 92%, respectively, of the corresponding whole grain.

The Se contents of wheat flours are affected by the blend of wheat milling fractions used to make them. Lorenz[13] found that the Se contents of wheat flour milled in several locations actually show that the apparent decrease in Se content due to the milling of flour varied enormously (i.e., from -5% to 86%). Although he concluded that the Se content of flour decreased as the extraction percentage of the patent decreased, his data showed that the apparent decreases were <u>not</u> related to either the extraction percentage of the patent or to the Se content of the whole grain. They were greatest for soft red winter and Ontario soft winter wheats (e.g., 31% and 42%, respectively) in comparison to the other wheats studied (e.g., hard red winter:

19%; hard red spring: 16%).

Most techniques used in western-style cooking (e.g., boiling, baking, broiling) do not cause appreciable losses of Se from most foods (Table 5). In fact, some cooking methods, such as those which remove fats from meats, cause apparent increases in Se in the cooked food. However, heat drying of breakfast cereals and boiling of asparagus and mushrooms (both of which are relatively high in Se) have been found to result in significant loss of (presumably volatile forms) of Se.

4. Selenium in Human Diets

Differences in geography, agronomic practices, food availability and preferences, and methods of food preparation result in differences in the dietary contents of Se among human populations. Because many of these differences are difficult to quantify, evaluations of Se intakes of specific human population groups are often not precise. General comparisons can be made, however, of the Se contents of different food supplies by using the average Se concentrations determined within specific major classes of foods in different locales. The typical Se contents of the major classes of foods in the US, presented in Table 2, are, for the most part, based upon actual analyses of foods. Where analytical values were not available and where it was considered reasonable to do so, estimates have been given by the author.

Several authors have estimated the average per capita daily Se intakes of adult Americans (Table 5). These Se estimates indicate that the Se intakes of residents of different regions are highly variable. Nevertheless, residents in the so-called low-Se portions of the United States (e.g., Northeast, Southeastern Seaboard, Pacific Northwest) have estimated Se intakes approximately 2- to 5-fold those of residents of Finland or New Zealand.

The most important sources of Se in the diets for most people are cereals, meats and fish. This is shown by the relative contributions of each class of food to the total Se intakes of residents of several countries, as estimated by several authors (Table 7). In general, meats and fish appear to contribute around 40-50% of the total intake. The Se contributions of cereals, in contrast, appear to vary with the total Se intake, indicating that the relative consumption of this class of foods may also be an important factor in determining the total Se intakes of population. Similar data from other countries shows that; whereas, cereals provide from about one-quarter to two-thirds of the dietary Se in countries with total Se intakes greater than about 40 ug per person per day, they appear to contribute only one-tenth to one-quarter on the total dietary Se in countries with intakes lower than that level (e.g., Finland, New Zealand, Italy). Dairy products and eggs contribute small amounts (i.e., up to 12 ug per person per day) of Se to the total intakes in most parts of the US (i.e., moderate Se areas). Vegetables and fruits, uniformly low in Se (when expressed on a fresh weight basis), provide only small amounts (less than 5% of the total intake) of the mineral in most diets.

Differences in patterns of food consumption, whether general ones due to cultural influences or specific ones due to personal preferences and food availability, can significantly affect Se intake. In a study of the Se intakes of Maryland residents, Welsh et al.[14] found that individual variation was great. Although the mean daily intake of Se by the 22 subjects in their study was 81 ug per person, approximately 17% of a sampling of 132 diets selected by those subjects were found to contain less than 50 ug Se per person per day. A total of 54% of the diets provided more than 150 ug Se per person per day.

Although the dietary Se needs of Americans are not firmly established, estimates have been made[3,28] suggesting that daily intakes of 50-60 ug Se per adult should be adequate. Because studies indicate that most Americans consume substantially more than that amount, concern for the Se status of our population should be greatest for those groups living in geographic areas of relatively low Se, as well as those whose habits are likely to provide small amounts of the element. For the purposes of addressing questions of Se and health in these and other groups, it is unfortunate that presently available food Se analyses are restricted to a relatively few geographic areas of the US. The usefulness of national values of food Se contents is, thus, limited, particularly for many types of food that are not widely distributed on national basis.

REFERENCES

1. Reamer, D.C. and Veillon, C., A double isotope dilution method for using stable selenium isotopes in metabolic tracer studies: Analysis by gas chromatography/mass spectrometry (GC/MS), J. Nutr. 113, 786, 1983.

2. Thomassen, Y., Ihnat, M., Veillon, C. and Wolynet, M.S., IUPAC interlaboratory trail for the determination of selenium in clinical material, in Proceedings of the Third international symposium on Selenium in Biology and Medicine, Combs, G.F., Jr., Spallholz, J.E., Levander, O.A., and Oldfield, J.E., Eds., Avi Publishing Co., Westport, CT, 1985.

3. Combs, Jr., G.F. and S.B. Combs, The Role of Selenium in Nutrition, Academic Press, New York, 1986, 525 pp.

4. Zabel, N.Z., Harland, J., Gormican, A.T. and Ganther, H.E., Selenium contents of commercial formula diets, Amer. J. Clin. Nutr. 31, 850, 1978.

5. Smith, A.M., Picciano, M.F. and Milner, J.A., Selenium intakes and status of human milk and formula fed infants, Amer. J. Clin. Nutr. 35, 521, 1982.

6. Morris, V.C. and Levander, O.A., Seleniuim content of foods, J. Nutr. 100, 1383, 1970.

7. Schroeder, H.A., Frost, D.V. and Valassa, J.J., Essential trace elements in man: selenium, J. Chron. Dis. 23, 227, 1970.

8. Watkinso, J.H., Changes in blood selenium in New Zealand adults with the importation of Australian wheat, Amer. J. Clin. Nutr. 34, 936, 1982.

9. Tan, J., Aheng, D., Hou, S., Ahu, W., Li, R., Zhu, Z. and Wang, W., Selenium ecological and chemico-geography and endemic Keshan disease and Kaschin-Beck's Disease in China, in Proceedings of the Third International Symposium on Selenium in Biology and Medicine, Combs, G.F., Jr., Slappholz, J.E. Levander, O.A., and Oldfield, J.E., Eds., Avi Publ. Co., Westport, CT. 1985.

10. Varo, P., Nuurtamo, M., Saari, E., and Koivistoinen, P., Mineral element composition of Finnish foods. III. Annual variations in the mineral element composition of cereal grains, Acta Agric. Scand., Suppl. 22, 27, 1980.

11. Wauchope, R.D., Selenium and arsenic levels in soybeans from different production regions of the United States, J. Agric. Good Chem. 26, 266, 1978.

12. Ferretti, R.J. and Levander, O.A., Effect of milling and processing on the selenium content of grains and cereal products, J. Agric Food Chem. 22, 1049, 1974.

13. Lorenz, K., Selenium in wheat and commercial wheat flours, Cereal Chem. 55, 287, 1978.

14. Welsh, S.O., Holden, J.M., Wolf, W.R. and Levander, O. A., Selenium in self-selected diets of Maryland residents, J. Amer. DIet. Assn. 79, 277, 1981.

15. Ullrey, D.E., Brady, P.S. Whetter, P.A. Fu, P.K. and Magee, W.T., Selenium supplementation of diets for sheep and beef cattle, J. Anim. Sci. 46, 559, 1977.

16. Ewan, R.C. Effect of vitamin E and selenium on tissue composition of young pigs, J. Anim. Sci. 32, 883, 1971.

17. Mahan,D.C. and Moxon, A.L., Effects of adding inorganic or organic selenium sources to the diets of young swine, J. Anim. Sci. 47, 456, 1978.

18. Scott, J.L. and Thompson, J.N., Selenium content of feedstuffs and effects of dietary selenium levels upon tissue selenium in chicks and poults, Poultry Sci. 50, 1742, 1971.

19. Combs, G.F., Jr. and Scott, M.L., The selenium needs of laying and breeding hens, POultry Sci. 58, 871, 1979.

20. Conrad H.R. and Moxon, A.L., Transfer of dietary selenium to milk, J. Dairy Sci. 62, 404, 1979.

21. Higgs, D.J., Morris, V.C. and Levander, O.A., Effect of cooking on selenium content of foods, J. Agric Food Chem. 20, 678, 1972.

22. U.S. Food and Drug Administration, Bureau of Foods Compliance Program Evaluation Report: Total Diet, Studies fiscal year 1974, U.S. Gov't. Print. Off., Washington, DC, 1975.

23. Ganapathy, S.N. Joyner, B.J., Sawyer, D.R. and Hafner K.M., Selenium content of selected foods, in Trace Element Metabolism in Man and Animals III, Kirchgessner, M., Ed., Technische Univ., Munich, 332, 1978.

24 Watkinson, J.H., The selenium status of New Zealanders, N.Z. Med. J. 80, 202. 1974.

25. Schrauzer, G.N. and White, D.A., Selenium in human nutrition. Dietary intakes and effects of supplementation, Bioinorganic, Chem. 8, 63, 1975.

26. Mahaffey, K.R., Corneliussen, P.E. Jelinek, C.F., and Fiorin, J.A., Heavy metal exposure from foods, Environ., Health Perspect. 12, 63, 1975.

27. Olson, O.E., Palmer, I.S. and Howe, S.M., Selenium in foods consumed by South Dakotans, Proc. S. Dakota Acad. Sci. 5, 113, 1978.

28. National Academy of Sciences, Food and Nutrition Board, Recommended Dietary Allowances, National Academy Press, Washington, DC, 1980.

Table 1. Methods of Analysis of Selenium in Biological Materials.

Method	Reported Detection Limit (ppm)	Sample Preparation	Known Interferences
Polorigraphic determination of piazselenol after reaction with diaminobenzidine	0.01	perchloric-nitric acid digestion	-
Cathodiac stripping voltametric following ion-exchange separation of Se	0.001	nitric-sulfuric acid digestion	preconcentration of Se on anion-exchange resin
Inductively coupled plasma atomic spectrometry with hydride generation	0.0005	HCl digestion	hydride generation matix effects
Direct current plasma atomic emission spectrometry	0.02	acid digestion	matrix effects
Atom-trapping atomic absorption spectrometry	0.025	O_2 combustion	mineral cations
Electrothermal atomic absorption spectrometry	0.003	thermal stabilization with Ni	matrix effects
Atomic absorption spectrometry with hydride generation	0.01	acid digestion; hydride generation	matrix effects (particiulary Cu,As, and Sb)
Proton-induced x-ray emission analysis	0.01	lyophilization: pelletization	pelletization
X-ray fluorescence spectrometry	0.04	lyophilization, pelletization	-
Isotope dilution with detection by combined gas-liquid chromatography/ mass spectrometry	0.0005	nitric-phosphoric acid digestion; chelation with 4-nitro-*o*-phenylene-diamine	-

Neutron activation analysis using ^{75}Se	0.02	-	-
"Fast" neutron activation analysis using ^{77m}Se	0.05	-	-
Fluormetric determination of piazselenol after reaction of Se^{+4} with 3,3-diaminobenzidine	0.01	nitric-perchloric acid digestion, or O_2 combustion	loss of volatilized Se if digests clar
Fluormetric determination of piazselenol after reaction of Se^{+4} with 2,3-diaminoapthalene	0.002	nitric-perchloric acid digestion, or O_2 combustion	loss of volatilized Se if digests char

Table 2. Typical Se contents of foods in the United States.[a]

	Se contents, ppm (fresh weight)		
	low-Se area	moderate-Se area	high-Se area
Cereal	.300	.330	.560
Vegatables	.010	.040	.070
Fruits	.004	.006	.006
Nuts and seeds	.190	.190	.200
Red muscle meats	.195	.210	.370
Organ meats	1.070	1.020	1.335
Processed meats	.350	.350	.375
Poultry	.100	.120	.410
Fish	.665	.665	.665
Shellfish	.710	.710	.710
Milk	.010	.030	.055
Cheeses	.085	.100	.300
Butter. cream	.006	.006	.016
Eggs	.060	.100	.450
Sweetners, condiments	.010	.010	.010

[a]Combs and Combs[3]

Table 3. Geographic variation in Se contents (ppm) of selected foods produced in the United States.

State of Origin	Hard winter wheat[a]	Hard spring wheat[a]	Soft winter wheat[a]	Soybeans[b]
Arizona	.05			
Arkansas				.16
Florida				< .07
Idaho	.10	.12	.06	
Illinois			.05	
Indiana			.13	< .07
Iowa				.28
Kansas	.20-.30			
Maryland				< .07
Minnesota	.83	.53-.70		
Mississippi			.05	.90
Missouri			.12	
Montana	.79-.85			
North Carolina				< .07
North Dakota		.43-.54		
Ohio			.04-.09	
South Dakota		.68		
Tennessee			.03-.08	
Texas	.25			
Washington		.64	.07	

[a]14% moisture basis, from Lorenz[13]

[b]air-dry basis, from Wauchope[11]

Table 4. Influence of the Se concentrations of livestock feeds on the Se contents of meat, milk and eggs.

Animals	Type of diet	Dietary Se[a] ppm (fresh weight basis)	Se content of food product ppm (fresh weight basis)			Reference
			Muscle	Liver	Kidney	
Steers			Muscle	Liver	Kidney	
	practical, low-Se	.085	.070	.258	1.483	15
		.206	.086	.384	1.372	
		.294	.100	.435	1.366	
	practical, high-Se	.199	.135	.498	1.458	15
		.255	.136	.499	1.578	
		.328	.158	.524	1.544	
Lambs			Muscle	Liver	Kidney	
	practical, low-Se	.085	.088	.242	1.207	15
		.206	.092	.380	1.261	
		.294	.110	.533	1.233	
	practical, high-Se	.199	.167	.618	1.301	15
		.255	.159	.656	1.351	
		.328	.167	.756	1.211	

			Muscle	Liver	Kidney	
Pigs						
	Se-deficient	< .02	.070	.084	1.25	16
		.05	.308	1.381	7.50	
	practical, low-Se	+.10 (as Na_2SeO_3)	.062	.233	1.129	17
		+.40 (as Na_2SeO_3)	.094	.464	1.218	
		+.10 (as fish meal)	.058	.167	.904	
		+.40 (as fish meal)	.122	.436	1.339	
		+.10(as browen's grains)	.093	.276	1.038	
		+.40(as browen's grains)	.116	.554	1.458	
Chickens			**Muscle**	**Liver**	**Kidney**	
	practical, low-Se (.07 ppm)	.07	.061	.25	.39	18
		.17	.071	.48	.34	
		.27	.103	.53	.80	
		.47	.114	.59	.56	
		.67	.126	.80	.62	
		.87	.157	.77	.71	
	practical, high Se (.67 ppm)	.67	.293	.80	1.08	18
		.87	.423	1.05	.98	

Turkeys			Muscle	Liver	Kidney	
	practical, low-Se (.07 ppm)	.07	.056	.15	.07	18
		.17	.07	.33	.14	
		.27	.08	.54	.13	
		.47	.11	.56	.12	
		.67	.10	.78	.16	
		.87	.10	.94	.17	
	practical, high-Se (.69 ppm)	.68	.32	1.03	.36	18
		.88	.35	1.06	.31	
Hens			Whole egg	Hen muscle		
	practical, low-Se (.04 ppm)	.04	.136	-		19
		.09	.252	-		
		.14	.260	-		
		.24	.295	-		
	practical, high-Se (.45)	.45	.325	-		19
		.50	.355	-		
		.55	.376	-		
		.65	.391	-		

			Milk	
Cows				
	practical, low-Se	+0	.010	20
		.094	.017	
		.225	.017	
	practical, high-Se	.334	.040	13
		.385	.047	
		.450	.064	

Table 5. Effects of cooking procedures on the Se contents of foods.[a]

Cooking procedure	Food	Se content, ppm dry matter		Apparent Se loss,%
		fresh	processed	
heat drying (100°, overnight)	wheat breakfast cereal	.039	.030	23
	oat breakfast cereal	.051	.047	8
Boiling, 5 min.	oatmeal	.078	.084	-8
	wheat cereal	.047	.051	-8
Boiling, 20 min	oatmeal	.078	.067	14
	wheat cereal	.047	.053	9
	polished rice	.023	.023	0
	egg noodles	.065	.061	6
	mushrooms	1.40	.78	44
	asparagus	.96	.68	29
Boiling, 45 min.	egg noodles	.065	.066	-2
Baking (175°C), 45 min.	chicken breast	.48	.49	-2
Baking (175°C), 60 min.	flounder fillet	1.38	1.51	-9
Broiling, 20 min.	lamb chops	.34	.34	0
	t-bone steak	.70	.60	14
Broiling, 45 min.	pork chops	.22	.20	9

[a]from Higgs eg al.[2]

Table 6. Estimated average per capita daily intakes of Se by adult Americans.

Area	Estimated intake, ug	Reference
low-Se	60-150	7
	147[a], 154[a], 198[a]	22
	82[b], 86[c], 93	23
moderate-Se	132	24
	90-168	25
	150	26
	81[d]	14
high-Se	191[a], 216[a]	22
	216	27

[a]estimates based on surveys conducted in different states

[b]ovo-lacto vegetarian diet

[c]strict vegetarian diet

[d]estimate by duplicate plate analysis

Table 7. Contributions of major classes of foods to the Se intakes of adult Americans.

Class of foods (reference)	Se intake; ug/person/day					
	moderate Se area				hi Se area	
Cereals	45[a]	(34%)[d]	93[b]	(62%)	57[c]	(26%)
Vegetables, fruits	5	(4%)	1	(0.6%)	10	(5%)
Meats, fish	69	(52%)	56	(37%)	101	(47%)
Dairy products, eggs	13	(10%)	0	(0%)	48	(22%)
Total	132		150		216	

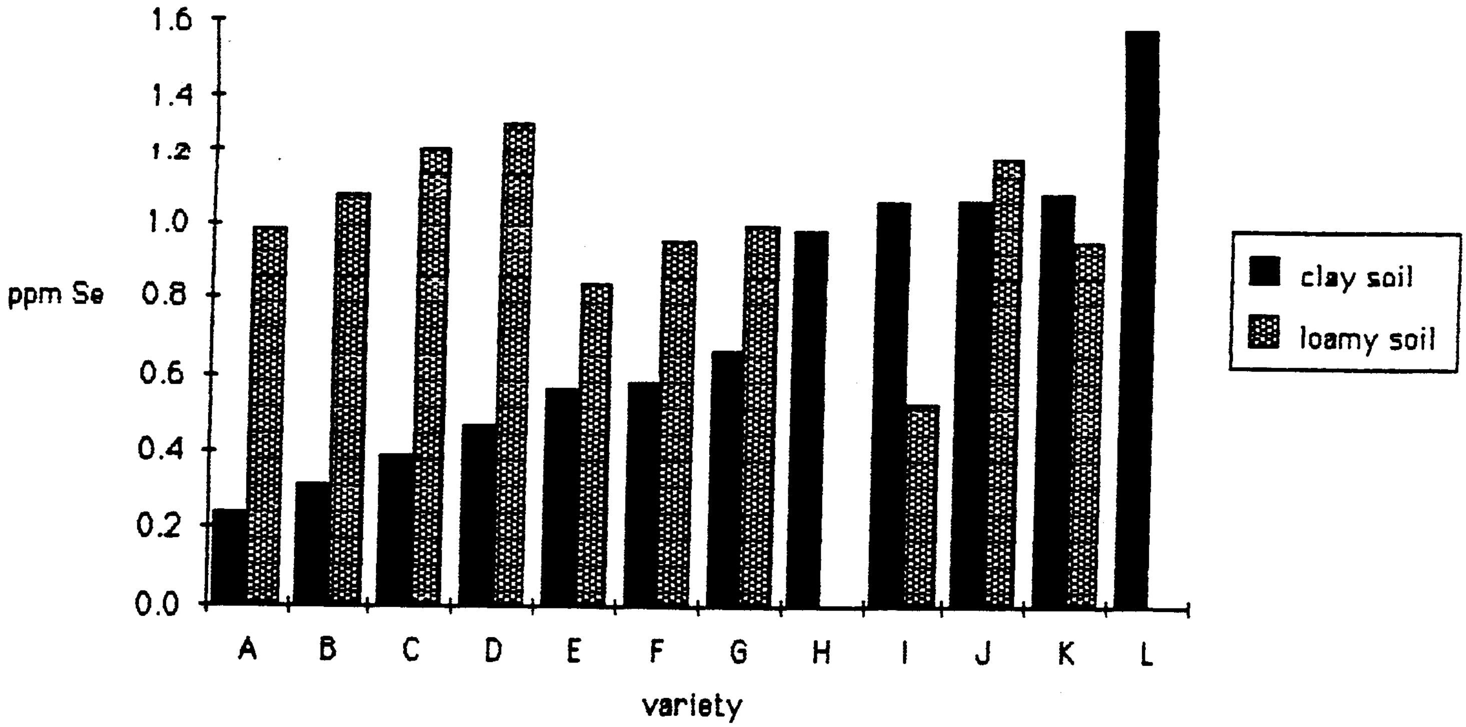
[a]USDA[22]

[b]Schrauzer and White[25]

[c]Olson et al[27]

[d]numbers in parentheses show the percentage of the total intakes contributed by each class of food.

Fig. 1 Se contents of soybeans grown on two soil types in Mississippi (Wauchope, 1978)



SUGARS

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Nutritionally speaking, sugars belong to the class of macronutrients known as Carbohydrates. Dietary carbohydrates are sometimes classified into groups, such as:

Monosaccharides - e.g. fructose, galactose, glucose
Oligosaccharides - e.g. lactose, maltose, sucrose, malto-oligomers
Polysaccharides - e.g. starch, cellulose, hemicelluloses, pectins

Mono- and oligosaccharides are usually referred to as sugars. For this presentation, I shall restrict my discussion to sugar analysis in foods.

There are numerous methods for determining sugars, however, only a few that are accurate, fast and applicable for sugar mixtures in complex matrices. Methods that are based on gas-liquid chromatography (GLC) and high-performance liquid chromatography (HPLC) are by far the most popular and useful. The following is a list of various topics related to these two chromatographic techniques.

GAS-LIQUID CHROMATOGRAPHY

Derivatives

For lack of volatility, sugars must be converted to their derivatives in order to be analyzed by GLC. The most widely used derivatives are: 1) trimethylsilyl ethers - the formation of anomers and thus the resultant multiple peaks produced for each sugar make quantitation difficult for mixtures containing more than two sugars. 2) trimethylsilylated oximes - on certain columns, the oximes of each sugar yield only one single peak. 3) alditol acetates - sugars are first reduced to their corresponding alcohols and then reacted to form acetates. Fructose and glucose, for example, will both give rise to sorbitol and become indistinguishable. 4) aldononitrile acetates - these derviatives can be formed only from aldoses and not ketoses, such as fructose.

Columns

There are three general types of column: 1) packed - metal or glass with OD (outer diameter) between 1/8" and 1/4" and ID (inner diameter) of 2 mm and 4 mm. 2) widebore - fused silica with ID of 0.53 mm, length of 10 and 30 m. 3) capillary - fused silica or glass with ID of 0.2 mm and 0.32 mm, length of 12, 25 and 50 m. Choice of a column depends on the resolution, sample capacity, and sensitivity needed for a specific separation.

Packings

A wide variety of stationary phases is available for packed columns, but relatively few for fused silica capillary columns. Those that are found to be suitable for separating sugar derivatives are: 1) 50% phenylmethyl silicone, 2) 5% phenylmethyl silicone, and 3) methyl silicone gum. The polarity of a column usually determines how well a particular mixture of sugar derivatives can be separated.

Detectors

The three most commonly used detector in GLC are: 1) thermal conductivity - a universal detector for all compounds. It is simple and inexpensive but requires good temperature and flow control. 2) flame ionization - responds to all organic compounds and has excellent stability. 3) electron capture - high specificity for halogenated compounds. These detectors all provide a wide dynamic range of responses.

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY

Columns

Most HPLC columns are made of stainless steel and they are available in various sizes. 1) analytical - ID, 2 - 6 mm; length, 10 - 30 cm and 50 - 100 cm. 2) capillary - flexible stainless steel with 0.2 mm ID, 0.5 mm OD and length of 25 cm. 3) microbore - ID, 1 mm and 2 mm with length of 25 cm and 50 cm. 4) cartridge - glass-coated stainless steel or radial compressed flexible tube, 8mm ID and 10 cm in length.

Packings

The ability to manufacture small particle size silica with uniform pore sizes and other synthetic spherical polymers is mainly responsible for the rapid advancement of HPLC column technology. For sugar analysis, four types of packings are available. 1) amine bonded silica - utilizes as mobile phase a mixture of acetonitrile and water. 2) silica modified with amine - also uses acetonitrile and water but with a small amount of amine added. 3) cation exchange - Ca, Pb or Ag loaded sulfonated polystyrene divinylbenzene resin, uses water as mobile phase. 4) anion exchange - quaternary ammonium functional groups attached to polystyrene divinylbenzene resin, uses dilute base as mobile phase.

Detectors

Refractive index measurement is often used for detecting sugars in HPLC, however, it lacks high sensitivity and is limited to isocratic elution. Sugars do not absorb light in the ultraviolet region, but they do in the near-ultraviolet region of 180 - 220 nm, where very high purity solvents are required. Recently, a few methods have been developed to react reducing sugars with aliphatic amines forming fluorogens, which can be quantified with a fluorescence detector. Sugars that have been separated on an anion exchange column with a sodium hydroxide eluant can be detected by oxidation at a gold electrode with triple pulse amperometry.

ANALYSIS OF A DIET COMPOSITE

I shall describe the procedures we used to determine sugar contents of a diet reference material, which is a composite of a day's menu collected from a Human Study conducted at the Beltsville Human Nutrition Research Center.

The freeze-dried and well-blended diet composite was extracted with n-hexane to remove excess lipids and the residue was dried and extracted with 80% methanol. Sugars that were extracted into dilute alcohol were separated and quantified by either GLC or HPLC.

To be analyzed by GLC, extract containing sugars was dried and derivatized as shown in Figure 1. Chromatographic conditions are given in Figure 2. Starting with dried sugar extract and ending with a GLC chromatogram, the entire procedure can be accomplished within 1-1/2 hours. For the analysis by HPLC, the same sugar extract was treated as shown in Figure 3 and analyzed under the conditions given in Figure 4. This particular procedure requires less than 1 hour of preparation and analysis time. Using these two methods, a good comparison was obtained between the values for individual sugars of the diet composite (see Figure 5).

There are certain precautions that should be taken at various stages of sugar analysis.

1. Any sample containing sugars should be dried in a vacuum oven with temperature set at no greater than 60°C and under pressure of no less than 10 mm mercury.

2. Samples containing more than 10% sugars should always be kept frozen in order to prevent sucrose hydrolysis or microbial degradation. (see Table 1).

3. Use of water for sugar extraction sometime leads to sucrose hydrolysis. (see Table 2).

4. For sample cleanup of sugar extract prior to HPLC analysis, strong anion exchange resins, e.g. Dowex AG1-X8 (hydroxyl form), should be avoided. The use of cationic exchangers or anion exchangers (chloride form) will not affect recovery of sugars.

BIBLIOGRAPHY

Baust, J. G. and Lee, R. E, Jr. Differential binding of sugars and polyhydric alcohols to ion exchange resins: inappropriateness for quantitative HPLC. J. Liq. Chromatogr. 5, 767-779 (1982).

Chen, C. C. and McGinnis, G. D. The use of 1-methylimidazole as a solvent and catalyst for the preparation of aldononitrile acetates of aldoses. Carbohyr. Res. 90, 127-130 (1981).

Grob, R. L. Modern Practice of Gas Chromatography. John Wiley, NY, 1977.

Honda, S. High-performance liquid chromatography of mono- and oligosaccharides. Anal. Biochem. 140, 1-47 (1984).

Johnson, E. L. and Stevenson, R. Basic Liquid Chromatograph. Varian Associates, Inc. Palo Alto, CA, 1978.

Lee, C. K. The determination of carbohydrates in foods. In: Developments in Food Analysis Technique-I. R. D. King, Ed., Applied Science Publishers, Ltd., London, pp.261-291 (1978).

Li,. B. W., Schuhmann, P. J., and Wolf, W. R. Chromatographic determinations of sugars and starch in a diet composite reference material. J. Agric. Food Chem. 33, 531-536 (1985).

Pike, R. L. and Brown, M. L. Nutrition: An Integrated Approach. 3rd ed. John Wiley, NY (1984).

Pirisino, J. F. High-pressure liquid chromatography of carbohydrates in foods: fixed-ion resin and amino-bonded silica columns. In: Food Constituents and Food Residues, Their Chromatographic Determination. J. F. Lawrence, Ed., Marcel Dekker, Inc., NY, pp.159-193 (1984).

Rocklin, R. D. and Pohl, C. A. Determination of carbohydrates by anion exchange chromatography with pulsed amperometric detection. J. Liq. Chromatogr. 6, 1577-1590 (1983).

Sawardeker, J. S., Sloneker, J. H., and Jeanes, A. Quantitative determination of monosaccharides as their alditol acetates by gas liquid chromatography. Anal. Chem. 37, 1602-1604 (1965).

Traitler, H., Del Vedovo, S., and Schweizer, T. F. Gas chromatographic separation of sugars by on-column injection on glass capillary columns. J. High Resolution Chromatography & Chromatography Communications, 7, 558-562 (1984).

SUGAR DERIVATIZATION PROCEDURES
TMS OXIMES

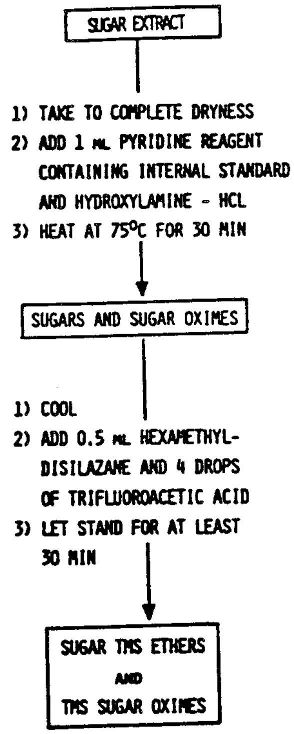

Figure 1

GAS-LIQUID CHROMATOGRAPHIC CONDITIONS:

CHROMATOGRAPH:	HEWLETT-PACKARD 5840A EQUIPPED WITH AN AUTOMATIC SAMPLER AND A FID
COLUMN:	6' x 1/8" STAINLESS STEEL COLUMN PACKED WITH 3% SP2250 OR 3% OV-17 ON 80/100 MESH SUPELCOPORT
COLUMN TEMPERATURE:	170°- 300° PROGRAMMED AT 10°/MIN
DETECTOR TEMPERATURE:	325°C
INJECTION PORT TEMPERATURE:	200°C
CARRIER GAS AND FLOW RATE:	HELIUM, 30 ML/MIN

Figure 2

SAMPLE PRETREATMENT
FOR HPLC

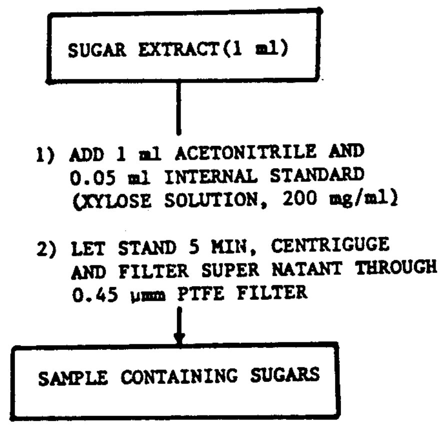

Figure 3

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC CONDITIONS:

CHROMATOGRAPH:	BECKMAN MODEL 110A PUMP, MODEL 156 RI DETECTOR, MODEL C-R1A RECORDING INTEGRATOR/PRINTER/PLOTTER
COLUMN:	WATERS ASSOCIATES RADIAL COMPRESSION Z-MODULE WITH RADIAL-PAK u-BONDAPAK NH_2 CARTRIDGE
TEMPERATURE:	AMBIENT
MOBILE PHASE:	75/25 ACETONITRILE/WATER
FLOW RATE:	2.0 ML/MIN.

Figure 4

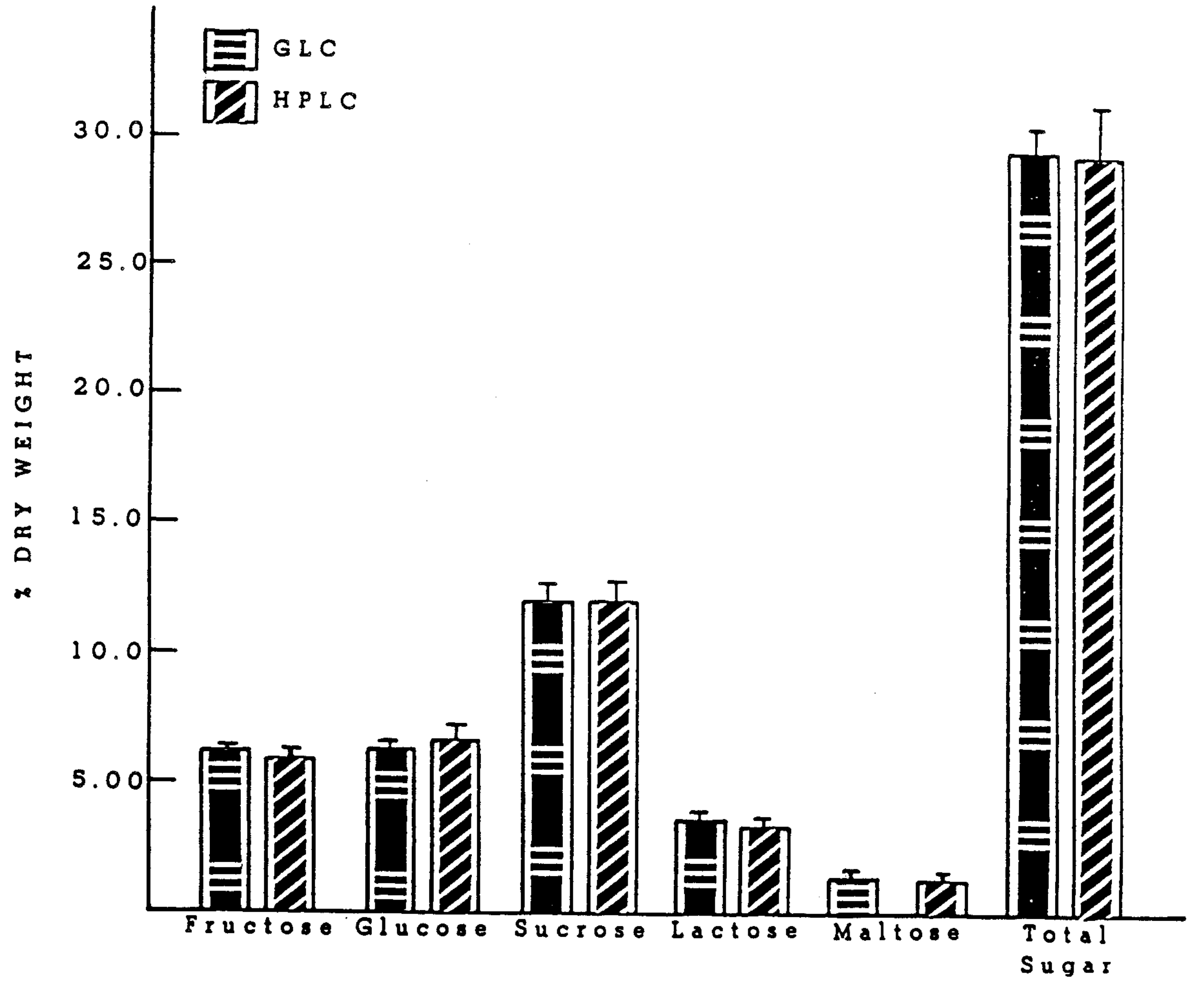

Figure 5 Sugar Contents of A Diet Composite, analyzed by Gas-liquid Chromatography and High-performance Liquid Chromatography.

Table 1. Effect of Improper Storage of Wet Diet Composites

storage temp. °C	time[1]	mannitol	fructose	glucose	sucrose	lactose	maltose	total sugar
			g/100 g dry wt					
-15°	5 mos.	N.D.[2]	6.38	6.19	12.6	3.67	1.62	30.4
4°	none	N.D.	6.29	6.14	12.6	3.64	1.50	30.2
4°	10 days	N.D.	7.66	7.50	9.50	3.66	2.32	30.6
20-25°	8 hrs.	N.D.	6.39	6.73	11.2	3.58	2.15	30.0
20-25°	16 hrs.	N.D.	6.63	6.91	10.6	3.58	2.44	30.2
20-25°	24 hrs.	4.51	7.42	6.10	N.D.	3.30	1.20	18.0
20-25°	48 hrs.	8.95	1.92	3.55	N.D.	3.02	0.82	9.31

1 Storage time after blending
2 N.D. - Not Detectable

Table 2. Sugar Contents of Granola Cereals Containing Raisins

Cereal	Extracting Solvent	g/100g dry wt				
		fructose	glucose	sucrose	lactose	total sugar
Quaker, 100% Natural	water	6.80	8.08	9.89	2.55	27.3
		6.85	8.06	9.71	2.26	26.9
	80% methanol	3.87	5.08	15.5	2.08	26.5
		3.85	5.24	15.4	2.43	26.9
Vita Crunch	water	1.90	1.95	21.2	-[1]	25.0
		1.92	1.98	21.3	-	25.2
	80% methanol	1.86	1.83	21.5	-	25.2
		1.89	1.88	21.1	-	24.9

[1] not detectable

BRITISH NUTRIENT DATABASE

Derek D Singer, Ministry of Agric., Fisheries & Food, UK

BACKGROUND

The UK Nutrient Data Bank started life in the 1920s with the work of Dr. McCance and Widdowson at King's College, London. Their work was funded for many years by the Medical Research Council (MRC) and published in scientific journals and as monographs. About 1940, the first complete set of data was published in book form but after 1960 there was little further development for a number of years until the Ministry of Agriculture, Fisheries and Food (MAFF) required updated information for its own purposes. Dr David Southgate at the Dunn Laboratory ,Cambridge, was commissioned by the Ministry with the agreement of the MRC to spend some time on new tables. The analyses were funded by MAFF and carried out mostly at the Department of the Government Chemist, where incidentally, at that time I was employed. More recently, work on the tables has been completely taken over by MAFF and is the concern of my colleague Dr David Buss.

Since 1976, I have been involved in the 'computerisation' of the data, particularly for use in the Food Science Division of the Ministry where it is applied to the many dietary surveys sponsored by the Department.

Prior to my involvement in the data bank, the data had been published on paper tape at the cost of about $250 in current values. Unfortunately the format was complex and a number of errors were incorporated. All copies have now been sold.

Our original programming was carried out on a small WANG 2200T machine and then on a WANG MVP using WANG BASIC2. The facilities included the ability to select foods by 'code' or name, to store recipes and diets and to use the data bank directly in the processing of surveys. A rapid string search of food names was available to help the user select the appropriate food without recourse to a written list.

Since 1984, the programs have been completely rewritten in FORTRAN 77 for use on a PRIME computer.

In the meantime the UK Government has been reviewing the cost effectiveness of many departmental activities and also the dissemination and possible profitability of Government information. One outcome has been that departments are now being exhorted to review ways of profiting from the sale of information where that information is a 'negotiable entity'. For example, the contents of our annual 'National Food Survey' can no longer be quoted in answer to 'phoned enquiries; the advice given is that 'the answer to your query will be found in the 'National Food Survey' price $2.50 published by Her Majesties Stationery Office"!

However the situation in 1983 was that many unauthorised copies of the data existed, some corrupted by insertion of non-official, unapproved figures. This data was often sold or freely diseminated via the invisible academic network, 'warts and all', without authorisation, together with computer programs of sometimes dubious value. Our publishing department had no immediate plans to publish the data in machine readable form in spite of the many requests received. Meanwhile sales of the book were healthy in the UK and in Europe, where it is handled by Elsevier of Holland (who market it at a price approaching three times that of the UK price).

Much of the data, although far from useless, was out of date. Although new analyses had been carried out and were used in our own work, the incorporation of the new data into published tables was becoming increasingly difficult as staff were heavily engaged on other activities. Accordingly, as Head of Information and Computing Services within Food Science Division I began to investigate the possiblity of contracting out not only the publication but also some part of the compilation of the tables.

For a time I had no success in finding a commercial publisher with the necessary all-round expertise but in 1984 I was asked to join the Users' Advisory Committee of the UK Royal Society of Chemistry. The Society is one of the largest publishers of chemical information in the world (it is said second only to the American Chemical Society) and earns the highest regard of the scientific community. It is experienced in the construction of databanks and databases as well as in the publication of hard-copy. In common with Government Departments and most UK academic and professional institutions, the financial climate was at that time was inducing it to take a firm commercial view of its activities as far as it could in the light of its status as a learned body.

At my first attendence at the Advisory Committee a request for suggestions for new databases or databanks was made and as an outcome my Division commissioned the RSC to carry out a market study of a new nutrient databank in the UK with some reference to a European Data Bank. The study showed that a new databank is a viable commercially and as a result the RSC will supply a nutritionist to work within our own Nutrition Branch in selecting and validating the data and will construct the databank in liaison with my own Branch for publication in various forms.

The discussions between the RSC and MAFF have been spread over 3 years. During this period we have talked with INFOODS and

EUROFOODS and attended their meetings. What follows is a selection of the problems and questions that have arisen from these forums in as far as they affect the UK scene together with a summary of the new features of the tables.

USERS & USES

Nutrient databanks are unusual in many respects.

First the data is used by remarkably disparate sets of users. Users are found in Government, academic institutions, industry, medical institutions, and within the general public and those who serve the general public.

Respectively, these organisations include departments within national Government (eg Departments, Armed Forces, prisons) local Government and the International Government (EEC and UN): schools and universities: food processors and distributors: doctors, dentists, epidemiologists and dieticians: writers, broadcastors, journalists, pressure groups, advertisers and the general public. Of late a new area has become important - the law - since nutritional labelling is now under active discussion.

These users have differing needs arising from their differing activities. In order to decide how to meet these needs we considered aspects of Information (Publishing), Computing and Nutrition and the interactions each have with the others.

INFORMATION/PUBLISHING PROBLEMS

A book is required. Should this book be bound or loose leaf? Loose leaf is convenient if updates are to be issued at comparatively short intervals - which has not been the practice in the past - but the cost is higher and the pages more subject to damage or loss.

What should the cost be? Clearly the publisher must make a profit - or at least not a loss! But should the cost reflect the full cost of the all the work contributing to the publication, including the analyses? Undoubtedly were we starting from nothing the costs of the analyses would be many millions of dollars. In the UK during the 70s the cost of analysing about 200 foods approached one million dollars at 70s monetary values. We conclude that the cost of analyses cannot influence the price of the publication.

In the UK the most highly regarded and trusted data is produced by government for its own use and other users have no direct influence on distribution, costs and copyright. A number of academics have taken the view that the data should be freely available. These persons would take a different view if they were asked to work for nothing, or to write books for free distribution. In the light of the high costs of analyses it seems reasonable that users should at least bear the costs of production and distribution.

Without control by the author department and the publisher the data would become diluted and corrupted by 'foreign' information - an obviously undesirable happening. The user will be protected from spurious data by the RSC copyright and licensing policy.

Who owns the data? Although we are now transferring responsibility to a commercial body, albeit one who is a learned society, all work sponsored by the UK Government is the copyright of the Crown. The new data will be licensed solely to the RSC who will be empowered to sub-license it as occasion demands. The data will be available internationally wherever there is a market and should be easily available via normal commercial outlets. It is likely that software houses will be granted sub-licenses to sell the data with their programs.

What should the data contain? The Ministry wishes to expand the data-bank to embrace the hitherto unincorporated data in its possession. One of the valuble properties of M&W is that the greater part of it arises from original analyses and this feature accounts for the supreme trust placed on it by users. Much other data is available but if extraneous data is included it should be tagged as such and it is likely that the data originating from the Ministry will be published either separately or as a clearly distinguishable part of the complete set.

The question of sets or subsets are important. The new databank could be very much larger than the old and its price accordingly higher. Not all users will require the full data. It is therefore likely that subsets will be available containing less detailed data or restricted to certain classes of foods in order to satisfy as many users as possible and take advantage of the full market. Publications might range from many volumes for research workers to pamphlets or booklets for the consumer.

Data tagging could be extensive. The number of samples is already a feature, but should the range of results be given? Should details of the samples be provided? This is discussed under nutritional requirements but involves agreement with, for instance, food processors if brand names are to be included and with authors and other publishers if literature is quoted. Data tagging might include the analytical methodology and relevant literature references.

Such data tagging adds considerably to the costs of the databank. It is likely that this information will be stored by the RSC and ourselves but only available on special request on computer readable media and of course at an appropriate price. In general, most users do not require detailed or extensive data; but a few might want everything available. These latter must expect to pay for the extra service.

COMPUTING PROBLEMS

There is an obvious market for the data in machine readable form. However the RSC market survey indicated that little market existed for an on-line service. It is possible that this result stemmed partly from a current shortage of funding for use of such services by the users within the UK and ignorance of such services by many questioned. However no firm decision has been made.

Users want the data in machine readable form for use in-house. Machines may be main-frame, mini- or micro, made by any of a number of manufacturers and using different media and formats. The data format could conform with one of the international standards, ISO or EUSIDIC.
The RSC will probably make tapes available in the format used by the large data base hosts and for mainframe and mini-computers such as the IBM, DEC, PRIME, HARRIS and for IBM, ATARI and other popular micros.

Purchasers will need to sign the usual agreement to protect the vendor against unauthorised copying. Copies for use on micros could contain internal protection.

It is unlikely that the RSC or the Ministry will provide programs to utilise the data and agreements with other organisations to provide various facilities for sale with the data under license are under discussion.

With some reluctance I must deal with coding. The need for a food code arises partly to enable data to be stored and programs to be written on small computers, partly for easy data capture during surveys, partly for easy programming to process surveys and partly for use as a mnemonic by everyday users.

The problems are manifold. Nutritionists like food groups. Most foods fall clearly into groups - cereals, milk and milk products etc. But is baby milk a health food or a milk product? Is a table jelly a dessert or a meat product? Anomalies and semantic considerations pose enormous difficulties and intellectual problems.

Do we use a hierarchical system, a network, a thesaurus or a faceted system? The problem is one of designing a system for all users and all uses. The more sophisticated it is, the less use it is as a mnemonic, the more complex it is for the non-professional computer programmer, and the higher the redundancy - which has to be paid for. The less sophisticated it is, the more anomalies and ambiguities will arise. The code that most suits data capture and entering survey data (data preparation) might not be optimal for data retrieval and processing. Experience with processing many UK Government surveys covering nutrients, contaminants and additives leads me to believe that it is best to design any coding uniquely for the particular survey. The results are better and less time and money is expended.

The USDA is to be congratulated in evolving its faceted system but the effort required to code a large data bank will be high and sooner or later someone will want to access and process the data in some way not covered by the system. I am still thinking how to apply it to the two hundred or more French cheeses or the many varieties of UK biscuits (cookies). Such systems possess high redundancy which can not be afforded by the average user. For use by the source organisation it is however not without attraction and resembles a system we had been considering for some years which uses multi-valued and associated fields and was intended to be universally applicable to an integrated nutrient/additive/contaminant data bank.

The new published version of the UK data bank is therefore likely to use sequential numbering, perhaps broken to signify the broad food groups. In other words there will be no coding system which contains information of high significance. However programs could employ inverted files containing descriptors appropriate to, let us say, the components of composite foods. A cheese file might be include the key word pizza and an associated field provide the cheese content. Searchers would then be able simply to ask for all foods containing cheese and to carry out calculations on cheese consumption with the certainty that pizza would be taken into account alongside other similarly coded cheese-containing foods. Inverted file software for micro-computers has become readily available over the past few years and the widespread use of Winchester disks offers the facility to store large inverted files. Recipes may conveniently be handled this way. Users can easily construct their own inverted files, or concordance to use the information terminology, to suit their own purpose. Such a system could be thesaurally based, but I do not support, in this application, a highly structured system.

NUTRITION

The data contained within a nutrient data bank is not immutable. New food products are developed such as snack foods, confectionery and desserts. Existing foods change in composition as different varieties of plants and animal are farmed. Animals are butchered in different ways. Fortification practices alter and composition may change with processing and packaging techniques. Manufacturers change constituents as the price and availability of alternatives fluctuate. Moreover, even in the small geographical area of the UK, food processors may change the composition of their products according to regional preferences.

As with all sciences, the emphases of nutrition change with time. Different data are required and some data decline in importance. Currently, except for some clinical purposes, there is less interest than formerly in amino-acids but more in sugars and individual fatty acids.

Compounding these problems, new analytical methods arise and occasionally new substances evoke interest.

Our own nutritionists are well placed to take note of these changes and, where relevant, appropriate values are used in official surveys. Table users outside of Government are generally not so well placed.

Since 1978, when MAFF assumed the sole responsibility for the tables, a large number of foods have been analysed. These analyses form part of a rolling program centered on the major staple food items, foods with high concentrations of selected nutrients and foods that are important in the diet of selected population groups, such as immigrants.

Supplementing this program are analyses of selected foods for specific nutrients in more detail. As a consequence we possess extensive data not presently incorporated in published tables. The data refer to more nutrients, some in greater detail and in some cases to regional and seasonal differences.

The additional nutrient analyses will fill many gaps in the tables and the additional nutrients selenium and iodine have been analysed in some foods.

The greater detail includes carbohydrates and Vitamin A. The current published tables cover available carbohydrate, sugars (lactose when appropriate), starch and dietary fibre. For many foods we now have data concerning individual sugars (sucrose, glucose, fructose, lactose, maltose etc). The dietary fibre figures are supplemented by components namely non-celluosic polysaccharides (hexoses, pentoses, uronic acids) cellulose and lignin. Similarly Vitamin A is covered in the current publication by retinol and carotene whereas we now have data on trans-retinol, 13-cis retinol, dehydro retinol, retinaldehyde and B-carotene. Regional and seasonal figures for the composition of bread and milk in seven different regions of the UK are now available and for potatoes we now possess new data for different varieties, regions and seasons. Some of those data has been published in scientific articles and some not. None appear in the published tables.

We will also supply the Society with extensive data on lipid contents of food not hithertoo generally available in easily usable tabulated form.

As already implied, it is hoped that manufacturers will also supply their own data for incorporation into the new tables. Many manufactures, perhaps most, are very willing to make data available.

Nevertheless there still exists many gaps. We ourselves draw on several sources including other analyses carried out in the UK, general literature values and the food composition tables of other countries - although data from the latter sources need careful consideration of their relevance.

We have briefly considered inclusion of bio-availablity. At present we think that the data are too fuzzy and open to mis-interpretation to include in the tables.

In constructing tables the MAFF has borne in mind the many uses and users both outside and within Government. There are clearly problems in constructing a table to suit all needs. The increasing interest and endeavour in nutrition and the generation of more foods and data, lead to many different but equally valid figures becoming available. We as the producer of the tables are in a position to select values according to application in the light of our background knowledge. However other users are not in this position. The current tables provide a 'representative' value. If we were to provide all the values in our possession how would the users select which to use, particularly if they did not have information either on the data or on the sample with which to base their selection? One does not buy powdered milk labelled 'from a Friesian cow, Southern England, April 1985' although in some cases such data would be very useful. In our survey of the diet on the Orkney Islands we used data on Orkadian foods. What use should be made of this data in the tables? A good deal of instinct and value judgment together with knowledge of market shares and the relevance of data spread is used in the choice of the representative values but users should be aware of uncertainties.

Inevitably, a nutrient data bank is more than a mere list. Numerical data are complemented by text which is important for users to read and understand. As the data grow in extent the significance of the qualifying and modifying information also grows. Whilst some of this textual information is amenable to tabulation or tagging eg analytical methods, preparation etc. some is not. Users must beware of using computerised tables without due observation of the context in which the data is derived and the text contained in the printed versions.

CONCLUSION

The new UK data bank aims to provide exended data, more rapidly updated than hitherto, in a variety of forms and formats and on a variety of media. Inevitably the new publication will be more costly than the existing one but subsets and condensed versions will be available. The Royal Society of Chemistry will be able to consider special requirements; it will set up a small advisory group and probably a User Group. The Ministry will continue to play the leading role in the provision and validation of the data and will ensure that no loss in quality will result from the commercial approach.

Finally I must mention the interaction with the international scene. The RSC market study revealed little interest in composite international tables. The UK is no longer the 'tight little island' it once was. The significant immigrant population and membership of the European Common Market has led to importation of many new foods, and people now travel more widely than they once did. This lack of interest does not therefore stem from insularity. Rather it is a indication that foreign food tables have insufficient relevance to the situation in the home country to justify any merging. When a demand arises it is not difficult to obtain a value - and for the large majority of users demand arises very infrequently. Interest is shown only by a few research workers, epidemiologists and those in other very specialised specialised areas. The difficulties of table production on a national scale are multiplied enormously on the international one. Whilst I admire the efforts of INFOODS and EUROFOODS, I would ask them to review their objectives and take heed of the costs of achieving them. The new UK data bank as yet has taken no account of these organisations since nothing has so far emerged from them that requires firm action. Any changes arising from international bodies will inevitably lead us to considerations of cost/benefit, international obligations and agreements and lead to political discussions. The achievement of a truly international nutrient databank seems a long way ahead; commonality in the overall presentation of data is certainly a lesser task than merger but even so does not appear to be required by many. In the meantime we can all benefit by exchanges between databank users and producers at all levels.

My thanks go to nutritionists Drs David Buss and Hazel Tyler for their patience and help in the production of this paper, to Hamish Kidd and Dr Ashe Kabi of the Royal Society of Chemistry, London, to Dr Piet Van Straten of Unilever, Netherlands and Dr Anders Moller of The National Food Institute (Denmark) for many hours of fruitful and helpful discussions on nutrient databanks.

USING USDA DATA TAPES

Betty Perloff and Brucy Gray
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Hyattsville, MD 20782

Three tapes containing nutrient data have been released by the Human Nutrition Information Service (HNIS) since the last Nutrient Data Bank Conference in July 1985. Brief descriptions of these tapes are given here. Additional details, including ordering instructions, are found in HNIS Administrative Report 378. Single copies of this report are available upon request from HNIS, 6505 Belcrest Road, Room 304, Hyattsville, MD 20782.

DATA SET 72-1, RELEASE 3, 1985

Corresponding publication: Home and Garden Bulletin No. 72, Nutritive Value of Foods, revised 1985
Number of items: 961
Number of food components for each item: 18 plus food energy
Units: Household measures

A 38-character description of each food item is included. A copy of the publication is required for complete descriptions of the food items. This data set is also available on floppy disk.

USDA NUTRIENT DATA BASE FOR INDIVIDUAL FOOD INTAKE SURVEYS, RELEASE 2

Number of items: Approximately 4,450
Number of food components for each item: 28 plus food energy
Units: 100 grams edible portion

This release was developed for use in the Continuing Survey of Food Intake by Individuals, 1985. Approximately half of the items on this data file were calculated from recipes. A coding manual in a format ready for printing is included on the tape. Food codes are seven digits.

DATA SETS USED TO CREATE USDA NUTRIENT DATA BASE FOR INDIVIDUAL FOOD INTAKE SURVEYS, RELEASE 2

The following three data sets are contained on one magnetic tape. These data sets were used to create the USDA Nutrient Data Base for Individual Food Intake Surveys, Release 2 (described above).

(1) Primary Nutrient Data Set for USDA Nationwide Food Consumption Surveys (PDS), Release 1.

Number of items: Approximately 2,400
Number of food components for each item: 28 plus food energy
Units: 100 grams edible portion

This data set includes data for all food items used to create the USDA Nutrient Data Base for Individual Food Intake Surveys, Release 2, including all ingredient items used in recipe calculations. Most of the data are from Release 5 of the USDA Nutrient Data Base for Standard Reference. Some changes were made to reflect current data soon to be used in the revision of Agriculture Handbook No. 8. Nutrient values were added to the PDS for nutrients not in the Standard Reference Data Base (e.g., total dietary fiber). Also, several additional foods and their complete nutrient profiles were added to the PDS. All items from the Standard Reference Data Base carry Standard Reference identification numbers, commonly called NDB numbers. Added food items have been assigned special NDB numbers. A list of food codes and descriptions, in a format ready for printing, is also included on the tape.

(2) USDA Table of Nutrient Retention Factors, Release 1.

This data set contains the factors for calculating retention of 16 vitamins and minerals during food preparation. It was used in the recipe calculations for the survey nutrient data base.

(3) Recipe File for Release 2 of the USDA Nutrient Data Base for Individual Food Intake Surveys

This data set controlled the generation of the survey nutrient data base using the PDS and the table of retention factors. In this file, each survey food code is linked to one or more PDS items through a set of recipe codes. Links to single PDS items are treated as one-component recipes. This file contains about 4,450 recipes, approximately half of which are direct links to single items on the PDS.

ETHNIC RECIPES - NETWORKING FOR PROGRESS

Linda Hicks, M.Ed., R.D., L.D.
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University of Texas System Cancer Center
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Houston, Texas

Our presentation addresses the challenges and frustrations experienced in both clinical and research settings when trying to analyze nutrient content of diets for ethnic populations -both individuals as well as groups. Granted, the United States is home to a wide variety of ethnic groups, however, our discussion today will focus upon the Southeast Texas area; specifically the City of Houston, Texas and surrounding counties. The most predominant ethnic populations represented in this geographical area other than Anglos and Blacks can be classified as Mexican-American and Vietnamese. Examples of recipe variations will be presented at the workshop. The availability and diversity of ethnic food items for which there is little or no nutrient data will be explored. Methods of working together to address these obstacles will be discussed.

Obviously, food consumption within these population groups is remarkably different from the typical American diet. Attempting to use computing resources and nutrient data bases to analyze nutrient content of a typical daily intake is extremely difficult and somewhat misleading. Because the nutrient composition data for many commonly consumed items are not available in most nutrient data bases, multiple food substitutions or the omission of a reported item due to its "uniqueness" severely compromises accuracy.

We have found, particularly with Mexican-American foods, that these foods are readily available to the South Texas population in a variety of forms i.e. fast foods, frozen food, and home prepared. Nutrient composition data is sometimes available for fast foods. The difficulty lies in obtaining data for ingredients used in home recipes. Food composition data for Vietnamese foods are practically non-existent. Lack of data is not the only difficulty encountered when attempting to analyze daily intake records. Other problems include language/communication barriers, food description/identification, regional recipe differences, and determination of the representativeness of the recipe as it pertains to the general population.

The Nutrition Methodology for Epidemiological Cancer Study funded by the National Cancer Institute has been conducted in Wharton and Matagorda counties in Texas from 1984 to the present by the University of Texas System Cancer Center M. D. Anderson Hospital. This research was designed to improve the methodology for collecting dietary intake data, especially in epidemiologic studies of cancer among different ethnic groups where previous dietary history is of critical importance. This study was divided into three separate phases.

Phase 1 involved the administration of a 24-hour recall to a randomly selected target population to determine what foods people actually eat. Phases 2 and 3, which began in January of 1985, built upon the information gathered in Phase 1. Those foods which were found to be widely used in the target population were included in the food list of the food frequency instrument used in Phases 2 and 3. The overall objective of this research was to develop a valid and reliable food frequency instrument which could provide retrospective dietary information on different ethnic groups.

In order to supplement the data in the nutrient data base at the Department of Cancer Prevention at the University of Texas M. D. Anderson Hospital and St. Luke's Episocpal Hospital/Texas Children's Hospital/Texas Heart Institute, the following sources were contacted:

1. Human Nutrition Information Service, USDA
2. University of Texas Health Science Center, San Antonio
3. University of Arizona
4. Food manufacturers
5. County extension agents
6. Other local researchers

Sharing nutrient data as it applies to research and/or hospital applications has proven to be mutually beneficial to both institutions. In addition, it has saved much valuable time and more importantly, has helped us as professionals to expand our network.

DATABASE VALIDATION PROCEDURES

I. Marilyn Buzzard, Yvonne A. Sievert, and Sally Schakel
Nutrition Coordinating Center (NCC)
University of Minnesota

The NCC nutrient database was established in 1974 to provide nutrient analysis support for two multicentered cardiovascular studies, the Multiple Risk Factor Intervention Trial (MRFIT) and the Lipid Research Clinics (LRC) programs. The database has been expanded over the past twelve years to meet the needs of other clinical trials and medical research studies involving cancer, diabetes and other diseases in addition to heart disease and hypertension. The current NCC database includes 71 nutrient values for approximately 1600 entries.

The nutrient database must be continually updated to reflect new or better analytic data, new products on the market, new formulations of existing products, and addition of new nutrients. The following procedures and guidelines are currently used by the NCC nutrition staff to ensure the integrity of the database and the calculation software.

EVALUATION OF NEW DATA

Nutrient and non-nutrient data are collected from various sources including government publications and computer tapes, the scientific literature, other published food tables, food manufacturers, and unpublished laboratory analyses. All data are evaluated by NCC nutritionists based on factors such as the data source, sample size and preparation, analytical method and use of reference standards. New USDA data sources are generally given the highest priority in selecting values for the nutrient database.

COMPUTERIZATION OF DATABASE MAINTENANCE PROCEDURES

Considerable effort has been made by the NCC staff to computerize as much of the database maintenance procedures as possible to eliminate the potential sources for error involved in manual procedures. Software has been developed to provide nutritionists with on-line access to all data in the database. Examples of on-line screen presentations of data are shown in figures 1 and 2.

Each update to the database is made to a temporary file. A printed report of the update is reviewed by a second nutritionist prior to posting the new value to the database. Following the update, a computer generated report showing old and new data is produced for the paper file for that entry. For each new entry, a profile of all the data for the entry is produced for the paper file. An example of a complete profile for whipping cream is shown in Figure 3.

Another software enhancement that has improved the accuracy and efficiency of maintaining the NCC database is the development of a system for computerized updating of the database directly from USDA computer tapes. The NCC database reference system provides a link between NCC and USDA entries for each NCC entry that is associated with a USDA entry. Before a computerized update is implemented, a report comparing NCC and USDA values is produced and reviewed by a nutritionist. Any large differences are investigated and verified with USDA nutritionists if necessary. While there is not always a one-to-one correspondence between NCC and USDA entries, the majority of the non-recipe NCC entries are based on USDA entries.

These software enhancements have eliminated the need for manually transcribing data onto update forms, submitting the forms to data entry operators for keying, and waiting for computer generated reports for cross-checking the new values. In addition to the considerable savings in personnel effort, the potential for error has been substantially reduced.

GUIDELINES FOR MAKING NUTRIENT MODIFICATIONS

Nutrient change limits have been established for each nutrient to guide database nutritionists in determining when the difference between a new and an existing value is sufficient to warrant a modification to the database. These guidelines are based on considerations of nutrient variability and dietary allowances. With the exception of the computerized updates from USDA data tapes mentioned above, modification procedures are generally implemented only when differences exceed the nutrient limit guidelines. This system eliminates the effort and potential for error involved in making changes to the database that are insignificant considering the nutrient variability within foods.

NUTRIENT LIMIT EDITS

Maximum nutrient limits have been established by food groups for each nutrient in the NCC database. These limits are based on review of the 20 foods highest in concentration of a particular nutrient for each food group. When new or updated nutrient values are entered into the computer, the values are compared with the established limits. Values which exceed the limits are flagged and must be verified by a nutritionist. Examples of nutrient limits for selected nutrients are listed in table 1.

DATABASE INTEGRITY CHECKS

Updates to the NCC nutrient database are made on a daily basis with an average of over 500 nutrient changes per month. A new version of the database is released every 6 to 12 months depending on the level of database activity and specific study needs. Prior to the release of an updated version, a number of computer generated integrity reports are produced for review by the database nutrition staff. These reports serve as a further check on the accuracy and internal consistency of the database.

The database integrity checks involve both calculated and non-calculated reports. Calculated integrity reports are used to compare calculations of various algorithms with known values. For example, the sum of the weight of the macronutrients plus ash and water is compared with 100 grams for each entry, or the sum of the caloric contributions of the macronutrients (including alcohol) is compared with the value for total calories. For each calculated report, the values of the individual parameters of the equation, the calculated value, the database value used for comparison, and the percent difference between the calculated and the database or expected value are listed in separate columns as shown in figure 4. An allowable limit for percent differences between the calculated and the expected values has been established for each calculated report. Any differences exceeding the established limits are flagged by asterisks on the report. All asterisked differences are investigated by a nutritionist to verify the sources of the database values and to make corrections if necessary. A listing of the various calculated integrity reports used by the NCC is presented in table 2.

Non-calculated integrity reports are listings of database entries grouped by NCC food groups. Nutrient or non-nutrient values are listed for each food in the food group, allowing the nutritionists to scan the listed parameters for any values that appear excessively high or low within a food group. Any outlying values must be either verified or corrected. Listings of the parameters for each non-calculated integrity report are presented in table 3.

COMPARISON OF REPEATED NUTRIENT CALCULATIONS OF TEST RECORDS

A test set of dietary intake records has been selected for repeated nutrient calculation on each version of the database. The records were carefully selected to ensure that a wide range of food items are represented and that all the software calculation procedures are invoked. After all integrity reports have been verified, the set of test records is processed, and the nutrient calculations are compared with the calculations from the previous version of the database. All differences must be verified as due to modifications made to the database since the previous version was released.

LIMITING THE NUMBER OF ELEMENTAL ENTRIES AND MINIMIZING DATABASE REDUNDANCY

Timely updating of the nutrient database and incorporation of the various quality control procedures outlined above can be accomplished only by making a concerted effort to limit the number of entries in the database that require routine updating. New items are added to the NCC database as recipe entries rather than as elemental entries whenever sufficient ingredient information is available or can be imputed. This procedure reduces the effort required for routine maintenance of the database since only the elemental entries must be maintained. Nutrient values for recipe entries are automatically recalculated when the elemental ingredients are updated. Approximately one-third of the current NCC database consists of recipe entries.

NCC procedures for minimizing database redundancy while maintaining maximum specificity for describing food intakes include the use of several hundred coding rules, brand name and food characteristic coding guides which specify the coding for over 4,000 commercial products and food types, computerized food preparation rules which permit the designation of any brand name or type of fat used in food preparation, and recipe modification procedures which permit detailed specification of fat and sodium containing ingredients. A system of multiple densities helps to limit the number of elemental entries by allowing a single entry to represent different forms of the same food. These features of the NCC system facilitate the coding for many thousands of home prepared and commercial products while maintaining a compact and complete database.

Table 1. Nutrient Edit Limits by Food Group for Selected Nutrients*

Nutrient	Food Group	Limit Value (per 100 g)
Calories	Fats, oils, shortening	900 Kcal
	Margarine, nuts, salad dressing	750 Kcal
	Candy, cookies, desserts, sugar snacks, spices	600 Kcal
	Fruit (except dried), vegetables, soup	150 Kcal
	All other food groups	500 Kcal
Protein	Meat, fish, poultry, cheese, spices	40 g
	Nuts, cereal	30 g
	Candy	20 g
	Eggs and substitutes	17 g
	Bread, crackers	15 g
	Legumes	10 g
	Vegetables, dairy products, soup	8 g
	All other food groups	5 g
Fat	Fats, oils, shortening	100 g
	Margarine, salad dressing	81 g
	Nuts	75 g
	Candy, snacks	50 g
	Meat, poultry, fish, meat substitutes, cream cheese, ice cream, eggs	40 g
	Baked goods	30 g
	Spices	20 g
	All other food groups	10 g
Calcium	Spices	2000 mg
	Cheese	1000 mg
	Other dairy products, soup, sauces, candy	300 mg
	Nuts, vegetables, bread, cereal, crackers	200 mg
	Cold cuts, fish, shellfish	120 mg
	All other food groups	100 mg
Vitamin C	Spices	200 mg
	Vegetables	175 mg
	Fortified beverages	140 mg
	Fruit, other beverages	100 mg
	Cereal, soup, sauces	60 mg
	Meat	30 mg
	Chips	16 mg
	All other food groups	3 mg

*Edit limits were established based on review of the 20 foods highest in concentration of a particular nutrient for each food group.

Table 2. Calculated integrity reports: allowable differences between calculated sum of nutrient components and actual or expected value.

Calculation Equation	Food Table Value or Expected Value	Allowable Difference
protein + total carbohydrate + total fat + alcohol + ash + water	100 gm	5%
4(protein) + 4(total carbohydrate - dietary fiber) + 9(total fat) + 7(alcohol)	total calories	12%
starch + sugars + total dietary fiber	total carbohydrate	10%
insoluble fiber + soluble fiber	total dietary fiber	10%
sum of amino acids	total protein	20%
total saturated fatty acids + total monounsaturated fatty acids + total polyunsaturated fatty acids	total fat	10%
sum of saturated fatty acids	total saturated fatty acids	10%
sum of monounsaturated fatty acids	total monounsaturated fatty acids	10%
sum of polyunsaturated fatty acids	total polyunsaturated fatty acids	10%
3.33 (retinol) + 1.67 (B-carotene)	total vitamin A	1%
alpha tocopherol + 0.4 (beta tocopherol) + 0.1 (gamma tocopherol) + 0.01 (delta tocopherol)	total alpha tocopherol equivalents	.01%

Table 3. Parameter listings for each non-calculated integrity report.

Report No.	Parameters
1	NCC reference food unit, food specific units (if applicable); weight and description for each unit; maximum serving size for the reference unit; density
2	Thiamin, riboflavin, niacin, vitamin C
3	B_6, B_{12}, folate, pantothenic acid
4	Calcium, iron, phosphorous, magnesium, vitamin D
5	Potassium, sodium, caffeine
6	Zinc, copper, selenium, chromium, manganese
7	Total fat, cholesterol, vitamin A, total alpha tocopherol equivalents (listed in order of fat content)
8	Fat code word assignment

```
                    Food Specification Screen
                           Code: 25015
           Name: EGG, WHOLE


Type        1            Food Groups:          Flags:  Fl. Oz.
Status      2              MRFIT 002500                CB Print
Ref Code    B01129         NCC   001504
Prep Code 4                LRC   281000        CB Cross-references:
Fat Code                   MLRC  281000           Group   Name
Dates: Added 02/01/75      MSHT  000501        1:
       Deact                                   2:
```

```
                      Units and Densities
                          Code: 25015
          Name: EGG, WHOLE

                                        Units:
 Food                           Max   -- ALIAS --
 Unit Common?  Weight Unit Intake Amount Unit            Description
 ---- ------   ------ ---- ------ ------ ----  -------------------------
1) SM           37.00  GM                      1 SMALL
2) MD           44.00  GM                      1 MEDIUM
3) LG     *     50.00  GM     4.00             1 LARGE
4) XL           57.00  GM                      1 EXTRA LARGE
5) JM           64.00  GM                      1 JUMBO

                                  Densities:
                 Type     Default?  Weight Unit   Volume Unit Ref
              ---------- --------  ------ ----  -------- ---- ---
           1) CHOPPED        *     136.00  GM    1.0000  CP   02
           2) SOLID                243.00  GM    1.0000  CP   81
```

```
                           Comments
                          Code: 25015
         Name: EGG, WHOLE


           1) S DENSITY BASED ON RAW, AH01123
           2)    (243 GM/CP RAW EGG).
           3) 44-SE: J.FD.SCI.49:446, 1984; ASSUME
           4)    LITTLE LOSS IN COOKING PER J.AG.FD.
           5)    CHEM. 20:678, 1972
```

Figure 1. Examples of on-line screen presentations of non-nutrient data for whole eggs.

Nutrients per 100 gm
Code: 25015
Name: EGG, WHOLE

Code	Ref	Value	Unit
W	02	74.80	gm
KCAL	02	158.00	kcal
PRO	02	12.10	gm
FAT	02	11.15	gm
TCHO	02	1.20	gm
CFIB	02	0.00	gm
ASH	02	0.90	gm
ALC	85	0.00	gm
CAF	85	0.00	mg
CHOL	02	548.00	mg
CA	02	56.00	mg
FE	02	2.10	mg
MG	02	12.29	mg
P	02	180.00	mg
K	02	130.00	mg
NA	02	138.00	mg
ZN	02	1.44	mg
CU	18	0.06	mg
CR		0.50	mg
SE	44	45.00	mg
MN	18	0.04	mg
VC	02	0.00	mg
THI	02	0.07	mg
RIB	02	0.29	mg
NIA	02	0.06	mg
PANT	02	1.73	mg
VB6	02	0.11	mg
FOL	02	49.00	mcg
VB12	02	1.32	mcg
BC	84	94.00	mcg
RL	84	109.00	mcg
VA	02	520.00	IU
ATC	41	0.70	mg
BTC			mg
GTC	41	0.35	mg
DTC	41	0.01	mg
TTC	84	0.74	mg

Code	Ref	Value	Unit
VD	17	1.25	mcg
SFA	02	3.35	gm
04:0	85	0.00	gm
06:0	85	0.00	gm
08:0	85	0.00	gm
10:0	85	0.00	gm
12:0	85	0.00	gm
14:0	02	0.03	gm
16:0	02	2.46	gm
17:0	85	0.00	gm
18:0	02	0.86	gm
20:0	85	0.00	gm
22:0	85	0.00	gm
MFA	02	4.46	gm
14:1	85	0.00	gm
16:1	02	0.37	gm
18:1	02	4.08	gm
20:1	85	0.00	gm
22:1	85	0.00	gm
PFA	02	1.45	gm
18:2	02	1.24	gm
18:3	02	0.03	gm
18:4	85	0.00	gm
20:4	02	0.09	gm
20:5	85	0.00	gm
22:5	85	0.00	gm
22:6	85	0.00	gm
GLUC			gm
FRUC			gm
GALA			gm
SUCR	85	0.00	gm
LACT			gm
MALT			gm
SORB			gm
MANI			gm
XYLI			gm
INOS			gm

Code	Ref	Value	Unit
XYLO			gm
ARAB			gm
RIBO			gm
RABI			gm
RAFF			gm
STAC			gm
DFIB	85	0.00	gm
ADF	85	0.00	gm
IFIB	85	0.00	gm
CELL	85	0.00	gm
HEMI	85	0.00	gm
LIGN	85	0.00	gm
WSDF	85	0.00	gm
PECT	85	0.00	gm
GUMS	85	0.00	gm
STAR	85	0.00	gm
ASPT			gm
TRYP	02	0.19	gm
THRE	02	0.60	gm
ISOL	02	0.76	gm
LEUC	02	1.07	gm
LYSI	02	0.82	gm
METH	02	0.39	gm
CYST	02	0.29	gm
PHEN	02	0.69	gm
TYRO	02	0.51	gm
VALI	02	0.87	gm
ARGI	02	0.78	gm
HIST	02	0.29	gm
ALAN	02	0.71	gm
ASPA	02	1.20	gm
GLUT	02	1.55	gm
GLYC	02	0.40	gm
PROL	02	0.48	gm
SERI	02	0.92	gm

Figure 2. Example of on-line screen presentation of nutrient data for whole egg.

Nutrition Coordinating Center (NCC)
University of Minnesota - Minneapolis, Minnesota
Reference Food Table Status as of 06/27/86

Code: 38240 CREAM, HEAVY, WHIPPING, 37% FAT

Type: 1 Status: 2 Ref Code: B01053 Prep Code: 0 Fat Code: .... Fl. Oz. Flag: Y CB Print Flag: .

DENSITIES

Type	Weight	Unit /	Volume	Unit	Ref
SOLID	238.00	GM	1.0000	CP	02

UNITS

Type	Food Unit	Weight	Unit	Max Intake	Description
Reference	CP	238.00	GM	1.00	....

-- Food Groups --
MRFIT ......
NCC 000508
MLRC 203000
MSHT 000901

Codebook Cross-References

	Group	Name
1:	......	....
2:	......	....

Comments:
1) 02-USDA AH8-1, #01053
2) 69-CU, CR, SE, MN: FINNISH FOOD TABLE
3) #6.06
4) 41-TOC: JADA 75:647, 1979: SWEET CREAM
5) 17-VIT. D: F&N ENCYC., #2043

--- Nutrients ---

Nutrient	Ref	Value	Nutrient	Ref	Value	Nutrient	Ref	Value	Nutrient	Ref	Value
Water	2	57.71	Vitamin B12	2	0.18	Total PFA	2	1.37	Cellulose	85	0.00
Calories	2	345.00	Beta-carotene	84	370.00	18:2	2	0.84	Hemicellulose	85	0.00
Protein	2	2.05	Retinol	84	256.00	18:3	2	0.54	Lignin	85	0.00
Total Fats	2	37.00	Total Vitamin A	2	1470.00	18:4	85	0.00	Wat-sol Diet Fiber	85	0.00
Total CHO	2	2.79	Alpha-tocopherol	84	0.63	20:4	85	0.00	Pectins	85	0.00
Crude Fiber	2	0.00	Beta-tocopherol	85	0.00	20:5	85	0.00	Gums	85	0.00
Ash	2	0.45	Gamma-tocopherol	85	0.00	22:5	85	0.00	Starch	85	0.00
Alcohol	85	0.00	Delta-tocopherol	85	0.00	22:6	85	0.00	Aspartame	85	0.00
Caffeine	85	0.00	Total Alpha-toc eq	41	0.63	Glucose	85	0.00	Tryptophan	2	0.03
Cholesterol	2	137.00	Vitamin D	17	2.50	Fructose	85	0.00	Threonine	2	0.09
Calcium	2	65.00	Total SFA	2	23.03	Galactose	85	0.00	Isoleucine	2	0.12
Iron	2	0.03	4:0	2	1.20	Sucrose	85	0.00	Leucine	2	0.20
Magnesium	2	7.00	6:0	2	0.71	Lactose	84	2.79	Lysine	2	0.16
Phosphorous	2	62.00	8:0	2	0.41	Maltose	85	0.00	Methionine	2	0.05
Potassium	2	75.00	10:0	2	0.93	Sorbitol	85	0.00	Cystine	2	0.02
Sodium	2	38.00	12:0	2	1.04	Manitol	85	0.00	Phenylalanine	2	0.10
Zinc	2	0.23	14:0	2	3.72	Xylitol	85	0.00	Tyrosine	2	0.10
Copper	69	0.01	16:0	2	9.73	Inositol	85	0.00	Valine	2	0.14
Chromium	69	4.00	17:0	85	0.00	Xylose	85	0.00	Arginine	2	0.07
Selenium	69	0.20	18:0	2	4.48	Arabinose	85	0.00	Histidine	2	0.06
Manganese	69	0.00	20:0	85	0.00	Ribose	85	0.00	Alanine	2	0.07
Vitamin C	2	0.58	22:0	85	0.00	Rabinose	85	0.00	Aspartic Acid	2	0.16
Thiamin	2	0.02	Total MFA	2	10.69	Raffinose	85	0.00	Glutamic Acid	2	0.43
Riboflavin	2	0.11	14:1	85	0.00	Stachynose	85	0.00	Glycine	2	0.04
Niacin	2	0.04	16:1	2	0.83	Dietary Fiber	85	0.00	Proline	2	0.20
Pant. Acid	2	0.26	18:1	2	9.31	Acid Detergent	85	0.00	Serine	2	0.11
Vitamin B6	2	0.03	20:1	85	0.00	Insol Diet Fiber	85	0.00			
Folacin	2	4.00	22:1	85	0.00						

Figure 3. Data profile for whipping cream.

Nutrition Coordinating Center (NCC)
University of Minnesota - Minneapolis, Minnesota
Food Table Integrity Queries
Version 13.0

Food Code	Name	PRO	TCHO	DFIB	FAT	ALC	Calculated Calories	Actual KCAL	Pct Diff	Exceeds Limit
54247	FIGURINES	20.80	39.60	0.00	30.19	0.00	513.31	517.00	0.71	
54361	ROLL, WHITE, PAN OR DINNER TYPE	8.20	53.00	2.80	5.60	0.00	284.00	298.00	4.70	
54403	ROLL, RICH, CRESCENT, REFRIGERATED DO	6.00	40.00	2.80	19.70	0.00	350.10	360.00	2.75	
55566	COOKIES, HIGH FAT, (HIGH SODIUM	7.20	65.10	0.73	23.10	0.00	494.18	498.00	0.77	
55574	COOKIES, MEDIUM FAT, (HIGH SODIUM	5.40	74.40	0.23	16.10	0.00	463.18	462.00	-0.26	
55582	COOKIES, HIGH FAT, LOW SODIUM,	7.20	65.10	0.73	23.10	0.00	494.18	498.00	0.77	
55590	COOKIES, MEDIUM FAT, LOW SODIUM,	5.40	74.40	0.23	16.10	0.00	463.18	462.00	-0.26	
55608	COOKIES, HIGH FAT, MEDIUM SODIUM,	7.20	65.10	0.73	23.10	0.00	494.18	498.00	0.77	
55616	COOKIES, MEDIUM FAT, MEDIUM SODIUM,	5.40	74.40	0.23	16.10	0.00	463.18	462.00	-0.26	
56416	HOSTESS SNOBALL,	3.30	64.00	1.00	12.00	0.00	373.20	380.00	1.79	
56440	HOSTESS DING DONG OR	3.40	57.00	0.88	27.00	0.00	481.08	490.00	1.82	
56457	HOSTESS HO HO,	3.60	61.00	0.95	24.00	0.00	470.60	470.00	-0.13	
56465	HOSTESS TWINKIE,	4.00	60.00	0.40	8.95	0.00	334.95	340.00	1.49	
56473	HOSTESS CUPCAKE,	3.40	61.00	0.95	13.00	0.00	370.80	380.00	2.42	
57612	PIE TART, COMMERCIAL, FRUIT FILLED	2.70	38.00	1.94	18.00	0.00	317.04	320.00	0.92	
58024	CONE, ICE CREAM,	10.00	77.90	0.80	2.40	0.00	370.00	377.00	1.86	
58115	TASTY KAKE, COCOANUT CREME PIE	6.40	39.10	1.15	27.50	0.00	424.90	467.00	9.01	
58248	PUDDING, CHOCOLATE, CANNED, COMMERCIA	2.70	22.00	1.03	5.29	0.00	142.29	150.00	5.14	
58362	TASTY KAKE, FRUIT FILLING PIE	3.40	46.10	1.94	12.57	0.00	303.37	320.00	5.20	
58396	TASTY KAKE, BUTTERSCOTCH KRIMPET	5.00	76.90	0.57	12.16	0.00	434.76	417.00	-4.26	
58404	TASTY KAKE, JELLY KRIMPET	3.80	70.80	0.40	7.42	0.00	363.58	367.00	0.93	
58412	TASTY KAKE, CHOCOLATE JUNIOR	4.90	68.40	1.06	15.62	0.00	429.54	393.00	-9.30	
58495	PUDDING, ALL FLAVORS EXCEPT CHOCOLATE	1.80	21.20	0.17	5.29	0.00	138.93	132.00	-5.25	
59014	CANDY BAR, CHOCOLATE COVERED COCONUT;	2.80	72.00	5.14	17.60	0.00	437.04	438.00	0.22	
59022	CANDY BAR, CHOCOLATE COVERED NOUGAT &	4.00	72.80	1.51	13.90	0.00	426.26	416.00	-2.47	
59030	CANDY BAR, MILK CHOCOLATE W PEANUTS;	14.10	44.60	5.48	38.10	0.00	555.78	543.00	-2.35	
59063	CANDY BAR, MILK CHOCOLATE W/O NUTS;	7.70	56.90	3.60	32.30	0.00	534.70	520.00	-2.83	
59071	CHOCOLATE, BITTER-BAKING	10.70	28.90	6.60	53.00	0.00	609.00	505.00	-20.59	*
59089	CANDY BAR, CHOCOLATE,	4.40	57.90	11.45	35.10	0.00	519.30	528.00	1.65	
59097	COCOA POWDER, UNSWT	16.80	48.30	34.00	23.70	0.00	337.70	299.00	-12.94	*
59113	MALTED MILK POWDER, DRY, PLAIN OR CHO	11.02	76.31	8.09	7.53	0.00	384.73	408.00	5.70	
59121	SAUCE, CHOCOLATE,	5.10	54.00	3.91	13.70	0.00	344.06	330.00	-4.26	
59139	SAUCE, CHOCOLATE, SYRUP TYPE,	2.30	62.70	2.72	2.00	0.00	267.12	278.00	3.91	
59154	CANDY, CHOCOLATE COVERED CHERRY,	3.80	70.30	2.14	17.10	0.00	441.74	435.00	-1.55	
59188	CANDY BAR, CHOCOLATE COVERED CARAMEL	7.70	64.10	3.22	18.10	0.00	437.22	433.00	-0.97	
59196	COCOA POWDER; PRESWT;	6.09	88.42	8.09	2.91	0.00	371.87	378.00	1.62	
59204	CANDY, CHOCOLATE COVERED ALMONDS,	12.30	39.60	9.56	43.70	0.00	562.66	569.00	1.11	
59212	CANDY BAR, MILK CHOCOLATE W ALMONDS;	9.30	51.30	4.94	35.60	0.00	543.04	532.00	-2.08	
59220	CANDY, CHOCOLATE COVERED PEANUTS,	16.40	39.10	6.66	41.30	0.00	567.06	561.00	-1.08	
59238	CANDY, CHOCOLATE COVERED RAISINS,	5.40	70.50	5.10	17.10	0.00	437.10	425.00	-2.85	
59246	CANDY, CHOCOLATE ROLL	2.20	82.70	1.63	8.20	0.00	406.88	396.00	-2.75	
59253	CANDY BAR, CHOCOLATE COVERED NOUGAT,	10.50	61.00	3.22	23.40	0.00	483.72	497.00	2.67	
59261	CANDY BAR, CHOCOLATE COVERED PEANUT	13.20	53.10	4.84	28.40	0.00	501.44	520.00	3.57	
59279	CANDY, TOFFEE	4.80	74.90	0.00	10.00	0.00	408.80	397.00	-2.97	
59287	CANDY, CHOCOLATE COVERED MARSHMALLOW	3.20	69.20	1.97	17.55	0.00	439.67	424.00	-3.70	
59295	CANDY, MALTED MILK BALLS	8.10	63.70	2.77	25.00	0.00	501.12	483.00	-3.75	
59303	CANDY, CHOCOLATE COVERED CREAMS	3.80	70.30	1.80	17.10	0.00	443.10	435.00	-1.86	
59311	CANDY, CHOCOLATE COVERED PEPPERMINTS	3.80	70.30	1.80	17.10	0.00	443.10	435.00	-1.86	
59345	CANDY, HALVAH, [illegible] = 1.406 CU IN	10.58	45.86	9.48	35.27	0.00	505.27	529.10	4.50	
59360	CANDY BAR, CHOCOLATE COVERED RICE	8.20	53.60	3.37	29.58	0.00	499.94	513.00	2.55	
59378	CANDY BAR, CHOCOLATE COVERED, TYPE	7.70	64.10	3.22	18.10	0.00	437.22	433.00	-0.97	

Figure 4. Example of one page of the calculated integrity report for calories. Differences exceeding the established limit are flagged in the final column.

DATA INTEGRITY - METHODS FOR DATA VALIDATIONS

Suzanne P. Murphy

The UCB Minilist, developed by the Nutritional Sciences Department at the University of California, Berkeley, is a relatively small but extensively used nutrient data base. We take pride in its integrity, and go to some length to validate the new entries every time it is changed.

Updates of existing nutrient values are the most common type of change that we make to the Minilist. We generally try to batch updates to coincide with new releases of USDA's standard reference tape. For a new "version" of the Minilist, a set of change sheets is generated showing the old and new nutrient values side by side, along with the percent difference. These are checked by our staff, and then circulated to all current users of the Minilist. In addition, we calculate old and new mean values for all nutrients, to be certain there are no drastic changes. Finally, we run several "model" diets through the system, and check to be sure the changes in the total are correct.

We can also run several validation programs: one adds the proximate nutrients (protein, fat, carbohydrate, water and ash) and compares the total to 100%; another calculates energy values by multiplying carbohydrate, fat, and protein, by 4, 9, and 4, and compares the result to the value on the data base for energy (alcoholic beverages are done separately); a third program adds the amino acids and compares the sum to the protein value. Any discrepancies that turn up are carefully checked.

Additions of new food items require more extensive validation, but the scale is usually smaller (one or two foods), so the checking can be more intensive. The new values are entered from a worksheet, printed, and sight checked against the original values. In addition, the validation programs mentioned above can be run.

Expansion of the nutrient data base to include new nutrients is by far the most complex of our maintenance tasks. It normally involves changes in our programs, as well as the data base. Obviously, extensive research is involved in order to find the best analytic values, and impute missing values. After each value is entered from a work sheet, it is sight-checked against a printed listing. Then we run model diets and check against hand-calculated totals. Finally, we try to find diets that have been analyzed for the new nutrient, and compare our calculated totals for the same diet.

Overall validation of the system is performed by comparing our results to those reported by other researchers using either analyzed values or different nutrient data bases. Our most recent validation was performed using over 1000 NHANES II diets of young women. The resulting nutrient totals were compared to those reported by NCHS for nutrients in common, and to literature values for the remaining nutrients. Discrepancies were noted, and their sources investigated.

In summary, we believe data validation procedures should be an integral part of every diet analysis system. They are often time-consuming, but valid research results often depend on an accurate and unbiased system. Data base users should always question developers about their methods of ensuring integrity.

LINKING NUTRIENT DATABASES--1977-78 NFCS TO CSFII 1985

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The Human Nutrition Information Service (HNIS) of the U.S. Department of Agriculture (USDA) is responsible for conducting Nationwide Food Consumption Surveys. The current survey being conducted by USDA is the Continuing Survey of Food Intake by Individuals, which began in April 1985. It is the first nationwide dietary intake survey designed to be conducted year-by-year in this country and is targeted at population subgroups. In the first year, data were collected for women 19 to 50 years of age and their children 1 to 5 years and for men 19 to 50 years of age. The Continuing Survey complements the larger Nationwide Food Consumption Surveys conducted by USDA approximately every 10 years, which includes dietary intake data on males and females of all ages as well as data on household food use and cost.

One of the biggest jobs in preparing for these surveys is developing a nutrient data base that includes all of the foods that Americans report eating. The nutrient data base is used to calculate the nutrient intakes of survey respondents. The nutrient data base developed for the 1977-78 Nationwide Food Consumption Survey contained over 4,500 food items, reflecting the abundance of food choices that Americans have. In preparing for the Continuing Survey, the food codes and nutrient data base used in the 1977-78 Nationwide Food Consumption Survey (NFCS) were updated and expanded. We developed a linkage system that allows the food codes used in the NFCS to be updated with nutrient values appropriate for 1985. This article explains the linkage system of the two data bases that was developed by USDA and is available to the public. It also briefly summarizes the changes made in updating and expanding the nutrient data base.

To understand the system that links the 1977-78 food codes with the 1985 nutrient data, we need to be aware of the changes that were made in the 1977-78 data base. The 4,500-plus foods in the nutrient data base of 1977-78 NFCS are identified by 7-digit food codes. In preparing for the Continuing Survey, the food codes and corresponding nutrient values were reviewed, updated, and expanded. Revisions to the food coding system generally include:

- elimination of items no longer marketed or infrequently reported in the 1977-78 NFCS
- addition of new food items on the market
- combination of items previously coded separately but which were reported infrequently and had very similar nutrient composition values, such as several varieties of fish
- separation of items--those coded as mixtures in 1977-78 such as coffee and cream or salad and dressing, into their component parts; and similar foods previously coded together, such as low-sodium and regular products. This was done because of the expansion of the nutrient data base to include fatty acids and sodium.

- changes made to food item descriptions to provide clarification and detail.

Based on the revisions to the food codes, all nutrient values in the nutrient data base were reviewed and updated to reflect new research information and the most current available data. There have been major changes in food composition data since 1977. Data for magnesium and vitamins B_6 and B_{12} are more reliable. Calcium and phosphorus values for some foods are higher. For example, more calcium has been added to some breakfast cereals. Phosphorus also increased as calcium was added in the form of calcium phosphate. Bacon now has phosphate added to reduce shrinkage during cooking.

Iron values have also changed. They are higher for white flour and for bread and other baking products made with white flour because of an increase in iron enrichment standards in 1983. They are lower for meat because of improved data. Vitamin A values are higher for carrots, sweet potatoes, and other deep-yellow vegetables because of the development of new varieties that are more intense in color, thus higher in beta-carotene, the precursor of Vitamin A. Vitamin A values for fruits are generally lower because of improved data.

NUTRIENTS

The revision of the food coding system, and moreover, the major review and expansion of the nutrient composition of the foods represents the largest change to a USDA survey nutrient data base over the past 20 years. In 1965-66, the NFCS covered food energy and 10 nutrients:

- protein
- fat
- carbohydrate
- calcium
- iron
- vitamin A
- vitamin C
- niacin
- thiamin
- riboflavin

Four nutrients were added in 1977-78. They were phosphorus, magnesium, vitamins B_6 and B_{12}. In 1985 for the Continuing Survey, 14 nutrients and dietary constituents were added to the data base:

- sodium
- potassium
- zinc
- copper
- folacin
- cholesterol
- total saturated fatty acids
- total monounsaturated fatty acids
- total polyunsaturated fatty acids
- vitamin A as retinol equivalents
- carotene as retinol equivalents
- vitamin E as alpha-tocopherol equivalents
- dietary fiber
- alcohol

LINKAGE SYSTEM

The expansion of data reflects the significant advances in assessing the nutrient composition of our food supply. Because of the major expansion and revisions to the data base in 1985, we wanted to provide a means of allowing the 1977-78 NFCS food code system to be used with nutrient values appropriate for 1985. We are also interested in evaluating the effect of these changes on the nutrient content of dietary intake data of the population. To address these areas, a linkage system was developed that matched every individual food item in the 1977-78 NFCS to the identical or most similar individual food item in the CSFII 1985 by means of the 7-digit food code. The linkage system provided the mechanism to match the food codes of 1977-78 NFCS with the most appropriate 1985 nutrient values. The linkage system consists of two parts:

- a computer listing of all 1977-78 NFCS individual food codes and the 1985 CSFII food codes that they match, as well as a link code that provides an explanation of the match.
- a data tape that includes all 1977-78 individual food codes and descriptions with their assigned 1985 nutrient values. The nutrient values were derived from the 1985 food code(s) matched to the 1977-78 food code.

The computer listing of the linkage file include the following information:

- the 1977 food code and description
- a weighting factor (WT) used when a 1977 food code is matched to more than one 1985 food code
- 1985 food code and description that match the 1977 food code
- a two-letter link code that identifies what happened to the 1977 food code in relation to the 1985 food code.

We categorized the matches by five different link codes. Most of the items in the 1977 food code system--about 3,800 out of nearly 4,600 (83 percent)--were retained essentially as in the 1985 food code system. Those matches were identified by the SS code. Our in-house definition of the SS abbreviation is that these food items stayed the same in the 1985 food code system. These food items, although the same, do not always have the identical description or food code number. Some of the descriptions were revised or expanded for clarity. Some food codes were changed because the item was moved to a different section in the food code manual. Some examples of matches that were given an SS code are listed below:

1977 Food Code	Description	1985 Food Code	Description
1111100	milk, cow's, fluid whole	1111100	milk, cow's fluid, whole
2140112	beef roast, roasted, lean only	2140112	beef roast, roasted, lean only eaten
2100020	beef steak, NFS	2110100	beef steak, ckd,NS as to fat
2110111	beef steak, with bone, broiled, lean and fat or NFS	2110112	beef steak, broiled, lean and fat eaten
2110112	beef steak, with bone, broiled, lean only	2110113	beef steak, broiled, lean only eaten

1977 Food Code	Description	1985 Food Code	Description
---	------	2110111	beef steak, broiled, NS as to fat
2410611	chicken, drumstick, with bone, broiled, skin eaten/NFS	2414121	chicken, drumstick, with or without bone, without skin, broiled
2410612	chicken, drumstick, with bone, broiled, skin not eaten	2414122	chicken, drumstick, with or without bone, without skin, broiled
---	-------	2414120	chicken, drumstick, with or without bone, broiled, NS as to skin
1461010	cheese cake	5310450	cheesecake
2736003	burrito, with cheese	5810012	burrito with beef, beans, and cheese
6340206	peach crisp	5341550	crisp, peach

The first two examples are food items which did not have changes in the description or food code. 'Fluid whole milk' and 'roasted beef roast, lean only eaten', are described the same and have the same food codes in 1985 as they did in 1977.

Some of the food item descriptions or codes were changed in 1985 to support the increased probing for detailed information that was implemented in the Continuing Survey. For example, the type of preparation method and explanation of "not further specified"--NFS--were added to many food descriptions in 1985. The 1977 item 'beef steak, not further specified', was matched to the 1985 item 'beef steak, cooked, not specified as to fat'. Food item descriptions were also changed to define fat moderation more specifically. In 1977, many meats were described as "lean and fat eaten" or "not further specified" as one item. These items were assumed to be untrimmed. In 1985, codes for these items were expanded to separate and designate "lean only eaten" and "lean and fat eaten". Most meat items also have a "not specified" designation in relation to fat for those respondents who did not know if they had trimmed or untrimmed meat. The 1977 item 'beef steak, with bone, broiled, lean and fat eaten or not further specified' was matched to 'beef steak, broiled, lean and fat eaten'. In 1985, a code has been added for 'broiled beef steak, not specified as to fat'. For codes not specified as to fat, it is assumed that fat is eaten. This assumption is based on the reasoning that the respondent is more likely to recall trimming the fat from meat.

Similar changes were made to poultry items. In 1977, many poultry items were described as "skin eaten" or "not further specified" as one item. In 1985, codes for those items were expanded to separate and designate "with skin" and "without skin". The examples of broiled chicken drumstick illustrate the separation of with skin, without skin, and not further specified. As with meat items, the not further specified designation for poultry items assumes that skin is eaten.

Some of the food items were moved to different sections in the code book, resulting in changes to the code numbers. Some examples include cheesecakes moving from the milk and milk products section to the cake subgroup of the grain products section. Mixtures made with meat and grain products such as the 'burrito with cheese' were moved from the meat, poultry, fish, and mixtures group to the grain products group. These mixtures were moved to group all mixtures containing grains--either with or without meat--into one section of the code book. Fruit crisps such as 'peach crisp' were moved from the fruit group to the grain products group.

A CC code--codes combined--shows that the 1977 food was combined with one or more other 1977 food items and assigned one food code in 1985. The items were very similar in nutrient composition. The description of the 1985 item encompasses the combined items. This includes 326, or about 7 percent, of the food codes. Listed below are examples of some of the matches classified as CC:

1977 Food Code	Description	1985 Food Code	Description
1141100	yogurt, homemade	1141110	yogurt, plain, whole milk
1321031	custard, homemade	1321030	custard, NFS
2512021	pork heart, cooked	2512000	heart, cooked, cooking method NS
2512031	veal heart, cooked	2512000	heart, cooked, cooking method NS
2611030	fish, blackfish, cooked, NFS	2613111	pompano, cooked, NS as to cooking method (includes blackfish, bluefish, ...)
2611031	fish, blackfish, fillet, broiled	2613112	pompano, baked/-broiled (includes blackfish, bluefish, ...)
5110110	bread, white, enriched	5110100	bread, white
5110150	bread, white, not enriched	5110100	bread, white

Homemade items such as yogurt and custard were combined with a similar item not described as homemade. Animal designations of organ meats other than liver were eliminated in 1985. Several types of fish that were infrequently reported in 1977 were combined in 1985. Product distinctions were omitted where level of detail was more than the respondent might be reasonably expected to know, such as whether breads were made with enriched flour. Most breads--about 95 percent--are made with enriched flour.

A DM code--deleted and matched--shows that the 1977 food item was deleted in 1985. We matched such codes to a 1985 food item that was similar based on description and nutritive value. This includes 296 (about 6 percent) of the food codes. The following are examples of DM codes. They include items not frequently reported in the 1977-78 NFCS or items that are no longer on the market:

1977 Food Code	Description	1985 Food Code	Description
2150140	beef, ground, patties, canned	2140140	beef roast, canned
2332311	moose meat loaf	2726001	meat loaf, NS as to meat

'Canned ground beef patties' was deleted in 1985 and matched with 'canned roast beef'. 'Moose meat loaf' was deleted and matched to 'meat loaf, not specified as to meat'. We did, however, keep cooked moose in the 1985 code book.

These three link codes--SS, CC, and DM--are one-to-one matches between 1977 and 1985 food codes. For about 200 of the 1977 food codes, it was not possible to match them with a single 1985 code. The 1977 codes linked to more than one 1985 code can be identified on the computer listing by a two-digit number in the weighting factor column. These include items deleted in the new coding system for which a similar single 1985 food item was not available to match, and items separated into individual ingredient components for coding in 1985.

The DD code--deleted and dropped--identifies that the 1977 food item was deleted in 1985, but that there was not a 1985 item that we considered to be a similar item to match it with. Therefore, the 1977 food item was matched to 1985 food items that make up its individual ingredient components. The value in the weighting factor column on the computer listing indicates the proportion of the ingredient in the 1977 food item, and the weighting factors total to 100. This factor is applied to each of the 1985 codes in determining the nutrient composition for the 1977 food code. This includes 80 (about 2 percent) of the food codes.

The following are examples of food items deleted in 1985 and matched to their individual components:

1977 Food Code	Description	WT	Description	1985 Food Code
1461051	cheese, cream with nuts	9	walnuts	4211600
		91	cheese, cream	1430101
6340204	prunes, stuffed with carrot	10	carrots, raw	7310101
		90	prunes, dried, cooked, unsweetened	6212222

'Cream cheese with nuts' is matched to 9 percent walnuts and 91 percent cream cheese. 'Prunes stuffed with carrot' is matched to 10 percent raw carrot and 90 percent dried prunes.

An IS code--which stands for item separated--identifies that the 1977 food item was separated into its individual ingredient components for separate coding in 1985. The 1977 food item was matched to 1985 food codes that make up its individual ingredient components. As mentioned for the DD codes, the proportion of the ingredient in the 1977 food item is applied to add up to 100 percent. This includes 94, or about 2 percent, of the food codes. Examples of IS codes are listed below:

1977 Food Code	Description	WT	Description	1985 Food Code
7212512	spinach, raw with dressing	23	French dressing	8310400
		77	spinach, raw	7212510
7511401	tossed salad with cheese, NFS, assume dressing	13	French dressing	8310400
		87	lettuce, salad with cheese, tomato and/or carrots, with or without other vegetables	7514320
9210105	coffee, from ground, with cream and sugar	3	sugar, NFS	9110100
		8	cream, half and half	1212010
		89	coffee, ground, regular	9210100
9230202	tea, leaf with cream	8	cream, half and half	1212010
		92	tea, leaf	9230200

Dressings for salads and cream and sugar in coffee and tea have been separated in 1985. Spinach and tossed salad with cheese have been coded separately from French dressing. Coffee and tea have been coded separately from the sugar or cream an individual would add to them. This separate coding was done as part of an overall procedural change in the 1985 Continuing Survey to look more definitively at type and amount of fat for estimating fatty acid composition and cholesterol.

The five link codes were used to categorize the match of every 1977 food code to a 1985 food code or codes. Verification of every match was conducted by comparing nutrient values of the 1977 food item to the 1985 food item or items it was matched to. Using this linkage system, a data base was developed that includes each of the 1977-78 NFCS food codes with its 1985 nutrient value from the 1985 CSFII nutrient data base.

The name of the data set is 1977-78 NFCS Food Codes (from Release 1) Linked to 1985 Nutrient Data Base (from Release 2). Release 1 and 2 are food codes and nutrient data bases for the 1977-78 NFCS and 1985 CSFII, respectively. The purpose of release 1- and 2-linked data base is to allow use of the 1977-78 NFCS food code system with nutrient values appropriate for 1985.[1]

SELECTED EXAMPLES OF CHANGES

The nutrient values in this data base are appropriate for dietary data collected from 1985. Use of this data base for analysis or reanalysis of dietary intake data collected before 1985 must be carefully interpreted. There have been several changes to the data base since 1977. New foods have been introduced on the market. The nutrient value of many foods have changed --some changes in the data base represent actual changes in the foods such as reformulation of food products, development of new varieties for more desirable characteristics, and changes in enrichment standards and fortification levels. Some changes in the data base reflect improvement in the nutrient data--more and better data for certain nutrients such as magnesium, and vitamins B_6 and B_{12} as well as improvement in analytical methods. The following illustrates some of these changes between the 1977 and 1985 data bases.

Since 1977, new sections of Agriculture Handbook No. 8, "Composition of Foods," have been published on pork products and on sausages and luncheon meats. One of the next sections to be published is on beef products. We have seen changes in vitamin B_{12} from these major sources.

Examples of food items from the meat, poultry, and fish group frequently reported in the 1977-78 NFCS are listed below to illustrate some of the largest changes in composition values for vitamin B_{12}:

	Frequency in 1977-78 NFCS	Data Base 1977	Data Base 1985
		--mcg per 100 gm--	
Beef, roasted	7,970	.84	1.88
Ground beef, fried	9,071	1.52	2.70
Bacon, cooked	15,181	.99	1.75
Pork chop, fried	2,472	.36	[illegible]
Pork, roasted	808	.32	.87

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[1] The data base is available for purchase in machine-readable form from the National Technical Information Service, Springfield, Virginia 22161.

In 1977, vitamin B_{12} values for many foods had to be imputed, and we indicated in our publication that the data base was less reliable for this nutrient than for others. Since then analytical methods have improved and reliable vitamin B_{12} data are available for many more foods.

Nutrient composition values for fruits and vegetables were also updated since 1977. Data in Handbook No. 8-9 on fruits and fruit juices and No. 8-11 on vegetables and vegetable products show the changes in vitamin A for numerous fruits and vegetables. Examples of food items from the fruit and vegetable groups frequently reported in the 1977-78 Nationwide Food Consumption Survey are listed below to illustrate some of the largest changes in the composition values for vitamin A:

	Frequency in 1977-78 NFCS	Data Base	
		1977	1985
		--IU per 100 gm--	
Apple	12,245	90	53
Banana	10,248	190	81
Carrots, cooked	2,861	10,500	24,408
Carrots, raw	2,615	11,000	28,129

Vitamin A values for fruits are generally lower because better data have been obtained. This change is illustrated by the levels for apples and bananas--two very popular fruits. The vitamin A in cooked and raw carrots more than doubled when updated in the 1985 nutrient data base. This is because new varieties of deep-yellow vegetables have been developed with more intense color.

Between the times when the 1977 data base and the 1985 data base were developed, two changes occurred that greatly changed the iron values of foods. New research on the nutrient content of meat and meat products showed lower iron levels than had been assumed earlier. Also, the Federal enrichment standard for levels of iron in white flour increased in 1983 from 2.9-3.6 mg per 100 grams to 4.4 mg per 100 grams. The decrease in the iron level of meats and increase in products made with enriched flour are represented by the following examples:

	Frequency in 1977-78 NFCS	Data Base	
		1977	1985
		--mg per 100 gm--	
White Bread	26,579	2.5	2.8
Ground Beef, fried	9,071	3.1	2.4
Fresh Ham, cooked	4,514	2.6	1.1
Pork, roasted	808	2.9	1.0

CONCLUSION

Nutrient data bases are constantly changing, improving, and expanding. Whether or not even a large change in the nutritive value of a particular food has a significant effect on overall nutrient intake by individuals depends on the amounts of the food consumed and the counterbalancing effects of changes in the nutritive values of other foods in the diet.

At HNIS, we are examining the effects of changes in the nutrient data base from 1977 to 1985. We will do this by recalculating the nutrient levels of diets reported in the 1977-78 NFCS using, via the linkage system, the 1985 nutrient data base. For comparing the 1977 and 1985 nutrient data bases, it is not a concern that some of the 1985 nutrient values are not appropriate for foods consumed in 1977. But this is a factor that users of the linkage system need to keep in mind. Our intent in releasing the linkage system is to help users who want to continue using our 1977 food codes but with updated nutrient values.

In evaluating the reanalysis of the data, we will be carefully interpreting the results based on the changes that have occurred in the data base since 1977-78. We plan to publish an administrative report on the study in 1987.

INTEGRATING NUTRIENT DATA WITH FOOD FREQUENCY DATA

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It was approximately five years ago that I began attending the National Nutrient Data Base conferences. Actually my first exposure to this group was at the meeting held in Philadelphia. My memory is very accurate about that because it was truly a mind-opening experience. At that time I was developing a research program with a focus in dietary methodology and a nutrient data base was an important tool. Prior to that meeting, I was unaware of the enormous number of considerations to be made in developing a nutrient data base that bear directly on the validity of dietary measurements.

Since that time, the field of dietary methodology has shown a fascination with the food frequency measure, largely fueled by the needs of the nutritional epidemiologist. Nutrient data bases have ceased to be an important tool and have become an integral feature in the design of the food frequency measure.

Despite variation in settings in which the food frequency technique is now used, there are some common elements to the questionnaires. First, all food frequency measures have a list of foods. Secondly, respondents are queried about their frequency of use of these foods, over some specified period of time. The final characteristic is the quantification of portion sizes. Some frequency instruments disregard quantification and estimate merely how often foods are consumed. Others are described as semi-quantitative in that they specify a typical portion size and provide the respondent with limited options for adjusting this amount. Still other food frequency measures are fully quantified by collecting accurate data on usual portion sizes from the individual respondents.

For the analysis of data collected using a food frequency measure, many of the previous concerns about nutrient data bases remain - availability of accurate nutrient values in their metabolically active forms and recipe calculations - to name only two. Some problems diminish in relevance - coping with the enormity of an extensive nutrient data base and accuracy in food code assignment by data collectors, for example. There are new problems to face. Empirical data is desirable for the identification of foods to include on a food frequency form. Composite food items are commonly developed from the highly specific food items contained in the nutrient data base. Nutrient values need to be assigned to these composite foods and this need is often accompanied by a need for typical portion sizes.

The purpose of this presentation is to understand the methodological issues involved in developing a nutrient data base to analyze dietary intake data collected using the food frequency technique.

1. PURPOSE FOR DATA COLLECTION AFFECTS DATA BASE NEEDS

A. Epidemiological Studies

Needs of the nutritional epidemiologist have dominated the development of the food frequency technique (1-7). It is not surprising, therefore, that attention has focused on the identification of foods whose use supports the epidemiologist's need for categorization of individuals into levels of nutrient intake. Important food sources of nutrients within populations have been identified (8-9), as have foods that account for the variability in nutrient intakes in a population (10). Since the goal in data collection is to accurately classify individuals on the basis of their usual intake levels of nutrients, precise quantification of dietary intake has not been stressed (11).

B. Food Habits Identification

The food frequency instrument has been used by nutritionists for many years to describe patterns of food use over varying periods of time (12-15). Since it is known to provide qualitative data only (16), it commonly is used as a cross-check for more thorough methods of dietary intake assessment. It has also been used to develop profiles of food intake in order to distinguish individuals or groups on the basis of patterns of food use (17). The information obtained may be general (for instance identifying "meat and potato eaters" versus "vegetable consumers"); specific in terms of the foods whose use is described (such as the use of designated, highly processed foods for GRAS classifications) (18); or highly specific in terms of how foods are prepared, to determine differences in practices that could influence health.

C. Nutrition Intervention Programs

Some programs are designed with specific dietary changes, or goals, planned. The food frequency measure may be used to supply evidence of the change process occurring. For this purpose, the instrument would have foods specified as desirable to change, or may have form or preparation of food as the targeted change. Therefore the foods on the food frequency list may be highly specific, or very general when used in connection with an intervention program.

2. QUESTIONNAIRE CONSTRUCTION AFFECTS NUTRIENT DATA BASE NEEDS

Several approaches have been followed by investigators in selecting the foods to include on a food frequency questionnaire. One approach is to select foods from an existing data base, or table of food composition, that are dense in the nutrient(s) of concern (19). The individual foods identified would, because of their selection process, have accurate nutrient data available from existing nutrient data bases.

More recently investigators have reasoned that it is preferable to ask about the frequency of use of foods known to be consumed by the population. Important food sources of nutrients are defined as those making the greatest percent contribution to the intakes of targeted nutrients by the population (8,9). Some interest has been expressed in constructing a single food frequency questionnaire for widespread applicability in nutrition research. Important food sources of most major nutrients are identified using national survey data (either USDA surveys of NHANES II). Individual foods that are highly similar in composition and role in the diet are grouped to form small food groupings, referred to as composite foods. The process results in a relatively short list of 25-125 foods that, in total, account for the population's intakes of the nutrients. This approach, however, requires information concerning appropriate nutrient values for these composite foods, values that must be calculated rather than extracted from an existing nutrient data base.

Some concern exists regarding the feasibility of one food frequency instrument designed for universal application. An alternative approach would be to identify the important food sources of nutrients within a population that is highly comparable to the study population (20). Such an approach is particularly attractive in an area, such as Texas, where distinctive regional or ethnic eating practices flourish. Investigators would need to acquire background data concerning foods actually consumed, and analyze them using conventional nutrient data bases. A food frequency questionnaire could then be constructed using the important food sources of nutrients for the specific population. A noteworthy advantage of this approach is that more detailed information is then available about the actual foods included in the composite food items, as well as their relative importance within the grouping.

3. CONSTRUCTING A NUTRIENT DATA BASE TO SUPPORT DATA ANALYSIS

These decisions, made at the time of questionnaire design, hold important ramifications for the construction of a nutrient data base to analyze the food frequency data. Questionnaire-specific nutrient data bases are advantageous, if not essential, to construct. The primary reason for believing so is that the food frequency technique makes use of a structured questionnaire format that defines the foods about which the respondent will be queried. There is no need, therefore, to assume the high costs and other inconveniences of a very large nutrient data base when nutrient values for only those foods on the questionnaire are relevant. Secondly, when a food list contains composite food items, there may be no valid nutrient values for these foods in existing nutrient data bases. Decisions to be made involve assigning nutrient values to the foods, and to issues of quantification of portion sizes.

A. Nutrient Values of Foods

1. Representative Foods

When the decision is to include foods that have been identified as used by, and important to the nutrient intakes of a specific population, the assignment of a food code is similar to this same activity when using a standard nutrient data base. You identify the most appropriate food code and accept the accompanying nutrient values.

Identifying the use of combination dishes or dishes made from special recipes, continues to defy resolution. Because the important food sources of nutrients are identified using standard techniques, such as the 24-hour recall or food record, the method used to code these special items will influence whether or not they can be identified as unique food items. When a mixed dish is coded as such, it has the potential of being identified as an important food source of nutrients for a food frequency questionnaire. However, when it has been coded by individual ingredients in a recipe, unless special coding procedures are adopted, only its ingredients can be identified as important food sources. It then becomes a matter of subjective decision-making to develop a list of foods for a food frequency questionnaire that accurately reflects important food sources that can be asked of the respondents in a manner that allows them to supply accurate data. For example, tomatoes may be identified as an important food source of vitamin C. When recipes have been coded by ingredients, the interviewer may have to ultimately ask the question "How often do you consume tomatoes in any form?" Familiarity with the actual food data may permit the investigator to realize that the tomatoes refer to tomatoes included in casseroles. The interviewer could then be more directed with the question "How often do you consume casseroles containing tomatoes?". This second question provides more focus for the respondent, thereby supporting a more accurate estimate of intake. Unfortunately such focus needs to be supported by empirical evidence.

2. Composite Foods

The assignment of nutrient values to composite foods presents more complex issues. In the identification of important food sources of nutrients, individual food codes in the data base are rank ordered on the basis of their percent contribution to the population's intake of the nutrient. Extensive lists of foods are generated. The investigator then must collapse the highly differentiated food items appearing in large nutrient data bases into groupings of comparable foods.

This procedure can be relatively simple for some foods. For example, natural cheese could consist of cheddar, Swiss, and colby cheeses. A serving of cheese could be defined as 2 oz. and the nutrient values of the three types of cheeses averaged to yield nutrient values for the composite food.

Other composite foods generate more serious difficulties. The simple carrot may not be that simple. Carrots are identified in NHANES II data as an important food source of vitamin A in the U.S. population. There are many forms of carrot identified, including raw, frozen, canned. Peas and carrots are identified as a source of vitamin A. It seems reasonable to decide that peas and carrots should be grouped with carrots as a source of vitamin A. A small extension of the argument permits the inclusion of mixed vegetables, canned as well as frozen, with carrots. Beef stew is identified as an important food source of vitamin A as well. It is then a subjective decision as to whether or not beef stew would form a unique group or included as carrots with a question such as "How often do you eat carrots, including carrots in stew?"

This process for defining the food group "carrots" is repeated for many other groups. It is a point at which subjectivity is included in questionnaire design, and as such, is a point that warrants close scrutiny. At this time there is no way to form the composite foods with purely empirical evidence. It is advantageous to include foods in the form in which they actually are consumed, a goal that at least partially justifies the acceptance of this subjectivity.

Once the composite foods are formed, the need is to assign nutrient values to them. One technique would be simply to average the values for each of the items included in the composite food. In some instances, such as the example of natural cheese, this procedure would be justifiable. It would be justified when each food has similar nutrient values and is approximately equally commonly consumed within the population.

In other cases a more intricate procedure would be recommended. A weighting scheme would be preferable when individual food items differ in nutrient composition and/or in the proportion of respondents consuming them. When weighting is instituted, the nutrient values of the composite food would be computed by weighting the values for the individual items by the relative contribution of the item to the consumption of all items comprising the composite food.

The ability to compute valid weighted nutrient values depends on the effective sample size on which the weighting is based. Some food items are very dense in particular nutrients. Liver, for example, is a very dense source of vitamin A. Such foods will probably be identified as an important nutrient source if only one person consumes it. In this case the effective sample size would be one. The estimated contribution to the intake of vitamin A would be highly unstable since it would double if one more person in the population were to consume it in an equivalent serving size.

There is no accepted method for computing the weighted values, or to know the sample size needed to develop stable estimates of the important food sources and corresponding accurate nutrient values. Currently I have the thought that to circumvent some of these difficulties, it would be advantageous to identify the important food sources of nutrients using one of the numerous, smaller nutrient data bases. The effect of doing so would be to force the interviewer, who actually collected the dietary data, to code foods using a more restrictive number of codes. This procedure would eliminate some of the subsequent subjectivity involved in forming the composite foods.

3. Dietary Goals

There are occasions when a food frequency questionnaire could be constructed using dietary goals rather than actual food consumption patterns. A nutrition intervention program may have an objective such as the reduction in the use of high fat, high sodium foods, or simple carbohydrates, or they may encourage the consumption of high fiber foods or complex carbohydrates. The food frequency technique has been used to measure the success of such programs. The identification of foods for inclusion on the questionnaire would not come from nutrient data bases, but from targeted, feasible behavioral changes. Foods could be selected in general form, such as whole grain cereals or processed meats. Also, relevant behaviors could include food preparation techniques.

A nutrient data base for this type of questionnaire would have nutrient values developed for these general items. It would be desirable to have such values reflect market share information. The data base would also have to accommodate precision in recording how foods are prepared, since food preparation may be a major point of intervention. An additional problem that may not be immediately apparent is that of obtaining nutrient data for new food products. Such programs frequently involve the adoption of dietary changes that the food industry is simultaneously supporting.

B. Quantification of Dietary Data

Food use data, when coupled with portion size data, can be used to estimate nutrient intake levels. Data analysis programs can be developed that compute nutrient intake values by assigning portion size values for each of the foods and automatically converting the frequency of use data to nutrient intake estimates. Some frequency questionnaires assign typical portion sizes, others obtain the quantification of food intakes from the respondents themselves.

1. Typical Portion Sizes

When either an unquantified or a semiquantitative food frequency instrument is used, level of nutrient intake can be estimated by applying typical portion sizes. These data, fortunately, are readily available in the U.S. from the national surveys utilizing national probability sampling, either USDA food consumption surveys or the NHANES surveys. These data have been published in several formats. The computer tapes are also available and can be used to compute typical portion sizes for many additional subgroups in the population.

A food frequency questionnaire can specify portion sizes, and if the acutal serving differs substantially from that, adjustments can be made in the reported frequency of use. NCI makes use of a semi-quantitative questionnaire that identifies a typical portion size and provides the respondent the opportunity to report if the the usual serving would be described as "small", "medium", or "large" relative to this. The computer analysis program would then have merely three options to use to convert the food use data to nutrient intake estimates.

Three options may not be sufficient in order to obtain accurate estimates. National survey data provides ample evidence that males and females differ significantly in their portion sizes, as do younger and older persons (21). There may also be differences attributable to race in portion sizes for specific foods. It would be a relatively simple extension of the established procedures to modify the data analysis programs to accommodate a larger range of typical portion sizes. Of course known portion sizes for specific populations, should that information be available, could also be used in constructing the data analysis program.

2. Calculated Portion Sizes

Other questionnaires may collect actual portion size estimates from the respondents, themselves. Expressed in another manner, a food frequency questionnaire can have less structure. A semi-structured questionnaire is able to collect more individualized data, but it does also restrict the amount of structure that can be built into the nutrient data base prior to analyses. Familiar problems to the seasoned nutrient data base user reappear. Respondents will vary in the units of measure they use in reporting portion size. A less structured data base would be needed that could convert several different units of measure to gram weights before calculating nutrient values. The more structured data base would have had the units predetermined and dealt with by merely expressing portion size as some multiple of these.

At this point a serious problem emerges for questionnaires in which portion sizes are collected for composite foods. The individual items included in the composite food commonly are identified with the gram weight of their average portion size in the population. This gram weight is highly influenced by the moisture content of the particular form in which the food is identified. For example, the gram weight of a portion of a food that is drained prior to serving is substantially smaller than a portion of an equal amount of solids served without draining. The designer of a nutrient data base for food frequency data needs to be careful in the conceptualization phase if this problem is to be accommodated.

I would suggest that one possible solution would be to express the portion size in household measures rather than as gram weights. This procedure would not be totally satisfactory for those composite foods that differ strongly in form. For example, if a food item, "tomatoes", were to include tomatoes in all its forms, it could include the units of measure of slices, measuring cups, glasses. Clearly these measures cannot be averaged. Their gram weights could be averaged, but the result would be very difficult to interpret.

No adequate method has yet emerged to resolve these problems. Anyone working in this field needs to be careful in making decisions that will influence the validity of the nutrient data base. In terms of the structure, nutrient data bases designed to analyze food frequency data have a simplicity to be envied by investigators working with the more comprehensive ones. On the other hand, nutrient data bases for food frequency measures place rigid demands a clarity in conceptualization. Many of the questions to be answered in designing data bases for food frequency measures have not yet even been identified. The National Nutrient Data Base Meeting provides a good forum for their identification and resolution.

REFERENCES

1. Abramson, JH, C Slome, and C Kosovsky. Food frequency interview as an epidemiologic tool. Am. J. Pub. Health 53:1093, 1963.

2. Hankin, JH, RA Stallones and HB Messinger. A short dietary method for epidemiologic studies III. Development of questionnaire. Am. J. Epidemiol. 87:285, 1968.

3. Mettlin, CJ and S Graham. Methodological issues in etiologic studies of diet and colon cancer. Nutr. Cancer 1:46, 1978.

4. Keys, A. Dietary survey methods. In: Nutrition, Lipids, and Coronary Heart Disease, R Levy, B Rifkin, B Dennis and N Ernst (Eds). New York: Raven Press, 1979.

5. Beaton, GH. What do we think we are measuring? Proceedings of the Dietary Data Collection, Analysis and Significance. Univ. Mass. Res. Bull. 675:36, 1982.

6. Rasanen L and P Pietinen. A short questionnaire method for evaluation of diets. Prev. Med. 11:669, 1982.

7. Lee, J, LN Kolonel and JH Hankin. Cholesterol intake as measured by unquantified and quantified food frequency interviews: Implications for epidemiologic research. Int. J. Epidemiol. 14:249, 1985.

8. Block, G, CM Dresser, AM Hartman and MD Carroll. Nutrient sources in the American diet; quantitative data from the NHANES II survey. I vitamins and minerals. Am. J. Epidemiol. 122:13, 1985.

9. Block, G, CM Dresser, AM Hartman, and CD Carroll. Nutrient sources in the American diet; quantitative data from the NHANES II survey. II macronutrients and fat. Am. J. Epidemiol. 122:27, 1985.

10. Byers, T, J Marshall, R Fiedler, M Zielezny and S Graham. Assessing nutrient intake with an abbreviated dietary interview. Am. J. Epidemiol. 122:41, 1985.

11. Block, G. A review of validations of dietary assessment methods. Am. J. Clin. Nutr. 115:492, 1982.

12. Young, CM and MF Trulson. Methodology for dietary studies in epidemiological surveys. II Strengths and weaknesses of existing methods. Am. J. Pub. Health. 50:803, 1960.

13. Stefanik, PA and MF Trulson. Determining the frequency intakes of foods in large group studies. Am. J. Clin. Nutr. 11:335, 1962.

14. Axelson, JM and MM Csernus. Reliability and validity of a food frequency checklist. J. Am. Dietet. Assoc. 83:152, 1983.

15. Mullen, BJ, NJ Krantzler, LE Grivetti, HG Schultz and HL Meiselman. Validity of a food frequency questionnaire for the determination of individual intake. Am. J. Clin. Nutr. 39: 136, 1984.

16. Sanjur, D. Food consumption surveys: Issues concerning the process of data collection. Chap 7 in: Social and Cultural Perspectives in Nutrition. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1982.

17. Davis, MA, E Randall, RN Forthofer, ES Lee and S Margen. Living arrangements and dietary patterns of older adults in the United States. J. Gerontol. 40:434, 1985.

18. Department of National Health and Welfare (Canada). Nutrition: A national health priority. Ottawa: Information Canada, 1973.

19. Willett, WC, L Sampson, MJ Stampfer, B Rosner, C Bain, J Witschi, CH Hennekens, and FE Speizer. Reproducibility and validity of a semiquantitative food frequency questionnaire. Am. J. Epidemiol. 122:51, 1985.

20. RS McPherson, E Randall, MZ Nichaman and GR Newell. Ethnic differences in food sources of nutrients of Texas residents: Implication for use of food frequency techniques in epidemiologic research. A paper presented at the Annual Meeting of the American Public Health Association, Washington, D.C., November 20, 1985.

21. Randall, E., MZ Nichaman and WD Spears. Variability in important food sources energy, fat and vitamin A in the U.S. population. A paper presented at the XIII International Congress of Nutrition, Brighton, England, August 21, 1985.

Workshop

Food Descriptor/Coding Schemes

Joanne M. Holden

Food composition data are used for the calculation of levels of intake of many components, both nutrients and non-nutrients, by many population groups and subgroups. In addition, such data are used to assess new agricultural practices and the different effects of manufacturing and preservation techniques. Furthermore, food composition data are used to formulate nutrition policy at national and local levels and to define food standards.

Today, computers are ubiquitous in the world of food composition research. Data manipulation by computer requires a well-defined and systematic scheme for efficient input and retrieval. Some uses of the data (e.g. calculation of nutrient intake from diet records) require the exact matching of foods in the master file with the foods reported by subjects or survey participants. Other uses of the data require the 'sieving' of data to retrieve foods which have one or more common characteristics. For example, one might want to conduct an evaluation of the differences in iron and zinc levels in wheat, corn, and rice breakfast cereals. Similarly, one might be interested in comparing the ascorbic acid content of frozen, canned, and refrigerated fruit products.

Although the level and kind of detail may vary from one database to another as well as from one source of input to another, the foods in any database must be well defined to permit the computerized differentiation of various products. The definition of a food or food product is composed of a collection of terms or factors which describe different aspects of the food. These may include:

Food Product Type (sometimes called food group)
Food Source
Physical State, Shape or Form
Degree of Preparation
Treatments Applied
Preservation Method
Packing Medium
Container or Wrapping
User Group

The terms which describe these aspects may also be called descriptors. The meanings of these terms are generally understood by the population of users. However, they are language and custom or region dependent. For example, the term 'grilling' can be synonymous with broiling <u>or</u> with griddling. In view of such problems the descriptors themselves require precise definitions.

The term 'code' has several definitions in the field of food composition research and data use. A code may be defined as a systematically arranged and comprehensive collection of laws (or rules). The 'food code' may refer to the body of rules and requirements which guide the use of a classification or nomenclature scheme. However, the term 'code' may also be used to define a system of symbols, letters, or words given certain arbitrary meanings, used for transmitting information requiring brevity. Numerical or alphabetic (or combinations of these) designations may be assigned to a list of foods for efficient computer manipulation. Finally, the word 'code' may be used as a verb, meaning to convert into code. A code is not as explicit as a descriptor, but a series of letters and/or numerals can represent a food description.

A vocabulary or scheme of food nomenclature must be flexible in order to permit the necessary addition of new foods <u>and</u> new factors. However, a flexible scheme can also be highly structured to assist users of the scheme in the orderly assignment of factor values within any factor. The controlled selection of factor values for data input will provide a powerful retrieval tool which will permit the accurate and precise evaluation of levels of intake and the relationship of these levels to health status.

RECIPE CALCULATIONS--NEW RESEARCH IN METHODOLOGIES

Patricia M. Powers, M.S., R.D.

Nutrient analysis systems have been applied to many aspects of dietetics. In the literature, numerous authors have described the automation of nutritional intake analysis that has occurred in government, school lunch programs, food industry, research, education, health care, and fitness programs. Professionals have applied the data generated with nutrient analysis systems to evaluate the adequacy of diets planned, served, and consumed. A key feature of these systems has been estimating the nutrients in foods as eaten by individuals and groups. Incorporating a recipe calculation method in software routines has allowed users to estimate nutritional values in a wide range of mixed dishes.

In a research project conducted at the University of Missouri-Columbia, four methods for computing the nutrient values of recipes were compared. Those four procedures were the yield factor method (1), retention factor method (2), direct addition of raw ingredients which was referred to as the summing method, and the procedure developed for the national school lunch program (3) which was referred to as the simplified retention factor method in this study. Two versions of the summing method were included in the comparison. In one version, the nutrient profiles of the raw ingredients were added and in the second, nutrient profiles of the cooked ingredients were added. The four methods were believed to be those most commonly used with nutrient analysis systems.

Distinctly different approaches were used in the four methods for computing the nutrients in recipes. The yield factor method utilized several yield factors to adjust ingredient weights and applied nutrient profiles that match the finished form of ingredients. In the retention factor method, nutrient profiles of raw or cooked ingredients were utilized. Nutrient retention factors were applied to the nutrient profiles of raw or cooked foods, and fat and moisture change percentages were applied to reflect overall changes in cooking. The summing method was a very simplistic procedure that involved adding the nutrients contributed by each ingredient to determine the total nutrient contents of recipes. The simplified retention factor method utilized a set of yield factors, retention factors, and fat change factors to compute energy and seven nutrients for the entire recipe and per portion.

Four pork entree recipes were selected for analysis with the calculation methods. The recipes were roast pork, pork and noodle casserole, pan-broiled pork chops, and pork chops with vegetables. Assumptions were made about the changes expected to occur in many of the ingredients. For methods that adjusted ingredient weights to exclude refuse and accommodated fat and moisture changes, adjustment factors, based on the stated assumptions, were applied. Thus, in those methods, changes were held constant to provide comparability of results.

Models were designed to simulate the algorithms of the calculation methods. A microcomputer spreadsheet software package provided the structure for the models. Values for 21 food constituents for the entire recipe, per portion, and per 100 grams were computed with the yield factor, retention factor, and two summing models. Energy and seven nutrients were computed for the entire recipe and per portion of the four selected recipes by the simplified retention factor model. The nutrient values generated by the models were compared to identify any differences. The nutrient values per 100 grams, computed with all models except the simplified retention factor model, were ranked to identify relationships of the models and consistencies in the recipes across the models.

The amount of differences among the models varied in the four recipes. Identical results were generated in the yield factor, retention factor, and summing-cooked models for the recipe with fewest ingredients (roast pork). The retention factor and summing-cooked models also produced identical results for the recipe for pan-broiled pork chops. None of the methods gave the same results in the recipes for pork and noodle casserole and pork chops with vegetables. In the pork and noodle casserole recipe, the retention factor model generated the highest values for all food constituents except water which was the lowest. The summing-raw model gave the highest value for water in all four recipes and the lowest values for most of the other food constituents.

The results from this study provided insight into the comparability of computerized recipe calculation procedures for recipes; however, the evidence was not sufficient to identify any one method as superior. Since laboratory analyses were not performed for the recipes, no standard was available with which to compare the results generated from the models.

The summing-raw method does not appear to be appropriate for calculating the nutrient composition in cooked mixed dishes even though that method was not compared with laboratory analyses. Since no provisions are made for adjusting ingredients in cooked dishes to reflect changes from preparation and cooking, incorrect estimations of nutrients are probably produced. Therefore, the summing-raw method should be avoided except for uncooked foods.

Implementation of any recipe calculation method, other than the summing-raw, requires judgement on the part of a coder. Each of the calculation methods involve distinct procedures, but when coding a wide variety of recipes, much interpretation and many assumptions are made that may influence the results. Although large amounts of data are currently available to support the calculation methods, more data are needed to supply information for the vast array of preparation and cooking procedures used in recipes. However, the amount of additional data needed could be minimized if a single general purpose method were designated as the preferred calculation method.

SELECTED REFERENCES

1. Andrews, J.T.: Development of a standardized recipe data file for computer systems. In: Moore, A.N., and Tuthill, B.H. (Eds.): Computer Assisted Food Management Systems. pp. 33-45, Columbia, MO: University of Missouri Technical Education Services, 1971.

2. Perloff, B.: Recipe Systems: Formulations and Calculations. Proceedings, Ninth National Nutrient Data Bank Conference, Amherst, MA, June 18, 1984 (In press).

3. Fulton, L.H., and Gray, B.: Microcomputer System for Assessing the Nutrient Content of School Lunches. Proceedings, Ninth National Nutrient Data Bank Conference, Amherst, MA, June 18, 1984 (In press).

SETTING UP REGIONAL NUTRIENT DATA BANK USERS GROUPS

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Working in the areas of nutrient data banks and dietary methodology can be confusing and overwhelming but also fun and challenging. Sometimes we are presented with problems of new terminology, conflicting terminology, new technology, conflicting technology, and lack of nutrient data. To share some of the pain as well as some of the gain, a group of us in Texas have set up a regional nutrient data bank users group.

Our main purpose in setting up such a group was to identify nutrient data base users in the Texas area and establish a communications network. We felt that a communications network would allow nutrient data bank users to share information and resources so that we are not all re-inventing the wheel.

We identified nutrient data base users in Texas from four sources: attendees of previous National Nutrient Data Bank Conferences; attendees of a Regional Nutrient Data Bank Conference hosted by The University of Texas System Cancer Center, M.D. Anderson Department of Cancer Prevention, Houston, 1983; all universities in Texas with programs in nutrition and dietetics; and local (that is, Houston) dietetic association members.

To publicize our first meeting which was held last October, we sent letters to individuals identified from the above sources and put notices in the newsletters of the local and state dietetic associations. The first meeting was held in Houston at the University of Texas School of Public Health. We had about 40 attendees at our first meeting.

The Program for the first meeting included a brief history on the use of nutrient data banks as well as a perspective on future applications. These perspectives were further illustrated by 2 case studies presented. One case study was presented by a new user - - a dietitian from the Texas Department on Aging who was just beginning to become involved with nutrient data banks. It was her responsibility to find and implement a nutrient data base/nutrient analysis program for use in analyzing meals at feeding sites for the elderly. The nutrient analysis was important to show compliance with government nutrient standards. Among her many other constraints, was the fact that the software had to be compatible with Texas Instruments' computers because these had been donated to her agency!

Dietitians from the Texas Department of Mental Health-Mental Retardation highlighted some of the problems of "old" users including decisions to switch to newer technology (even when doing so would mean the re-analysis of hundreds of recipes and many hours of re-training time).

At the users meeting, we divided into discussion groups by application area: food service/government, clinical, education and research. Each discussion group was asked to identify problem areas. Some of these included: lack of management/staff commitment to maintaining the nutrient data base; competition for use of terminals to access the system; long turn around time; lack of nutrient data for ethnic or regional foods; and lack of educational software for the university level such as a least cost menu program in the food service management area.

At our first meeting, we obtained information from each attendee including mailing information, specific information about the nutrient data base currently being used, and ideas for projects.

Numerous potential projects were identified. We have developed a mailing list of approximately 100 nutrient data base users in the Texas area. The mailing list has already been used 3 times - to distribute proceedings of the first meeting, to inform users of a Hispanic HANES Workshop held in February at the University of Texas School of Public Health, and to remind users of this meeting in Georgia.

Users were very interested in having a microcomputer software demonstration whereby dietitians (users) could demonstrate systems they were using, pointing out positive and negative features. Although this project has not been initiated yet, we plan for each user to analyze the same standard menu using different nutrient analysis systems and compare results.

Another project we hope to implement is a newsletter. The purpose of the newsletter is to announce professional meetings, announce and possibly review new publications, report the progress of special interest groups such as the ethnic foods group, and have a question and answer column.

Several attendees expressed a need for an ethnic foods interest group. As many of you may have seen yesterday in the workshop presented by Pat Pillow and Linda Hicks, the many ethnic groups in Texas present special problems to nutrient data base users.

Another project of our users group is to be a resource to nutrient data bank users who are not nutrition professionals such as elementary and secondary school educators and researchers in the diet and behavior area.

A suggested library bookshelf is being planned. Hopefully, this will identify important written resources for new users in particular.

Although we have not initiated all of the projects, we are pleased with the interest and response. The communications network has been beneficial already as users with similar needs and interests have been linked in several specific instances. We feel that our users group will be invaluable next year when Houston is host to the 12th National Nutrient Data Bank Conference. Please consider this a formal invitation to attend next year.

FOOD FREQUENCY AND RELATED METHODS TO STUDY DIETARY PROBLEMS IN GEORGIA

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DIETARY PROBLEMS. Georgia is an excellent state for the study of human nutrition. At one and the same time it has: a) well-defined regions of malnutrition, b) excellent health, school and demographic statistics, and c) well-trained nutritionists with good laboratories and survey methods well-suited to working with these problems.

Sauer (15) has pointed to a region of Georgia in which one finds the highest death rates in the nation for stroke, hypertension and coronary heart disease. The entire December 1971 issue of the ARCHIVES OF INTERNAL MEDICINE was devoted to the epidemiology of one county in this region. The average life span in this region is 10 years less than the national average. We have studied the diet of aged persons in this (11) and other counties (3) of the state. If you look for those counties in the state with the highest death rates from kidney and liver disease, most are in this same region.

If you look at school test statistics, you will find poor performance on the Basic Skills Test and you will find low IQ scores in this and adjacent regions of south Georgia. Not surprisingly, this same region constitutes one of the more durable poverty areas in the nation.

There are those who say that all of this is a genetic/racial problem due to the large number of blacks in the region. A further look, however, shows that the health problems are shared by both black and white, and the mental retardation is seen in both black and white families.

Those interested in diet will further note that this region of south Georgia shares a common soil band and has the same agricultural and garden crops. Further direct studies (6) show that there is a diet pattern common to this area. If the problems described above are indeed diet-related, it is time that the human nutritionists in the state start to work very directly with this matter. Georgia will never move ahead economically or otherwise until this problem is solved.

MENTAL RETARDATION. One of the serious problems cited above relates to mental retardation. Georgia has twice the number of retarded that you would expect from the national average--and a large number are centered in the soil band that we pointed to in south Georgia. A few years ago one of the Special Education teachers in south Georgia invited us to work with selected school populations. And we were able to get diet histories on the mothers of 200 school children in 5 schools, representing a wide range of IQ scores.

A study of these maternal diets by factor analysis methods revealed that the mothers of the mentally retarded had diets that were different than the diets of the mothers of children with normal or higher IQs. This was shown graphically by factor analysis, but no significant differences in nutrient intakes were to be found. By using the t-test directly on food consumption records, it was found that there were statistically significant differences in the food consumption patterns. The mothers of the retarded ate more corn bread, corn grits, peanuts and rice than did the mothers of the normals. The diet was also high in fat and contained more than adequate amounts of milk. We found ourselves confronted with a significant relationship between diet and mental retardation--without any nutrient deficiency or imbalance to point to (9). Since the problem did not seem to reside in a deficiency of nutrients, it seemed reasonable to look into possible toxic effects. It is true that these foods (corn, rice, peanuts and milk), when produced, stored and used in a hot, moist climate can be potent sources of aflatoxins (mold toxins).

To make a long story short, we were able to demonstrate (14) a firm relationship between the aflatoxin in the maternal diet and the IQ of the child. This required the development of new thought processes and new computation procedures on our part, for the usual nutrient computation procedures are not well adapted for the estimation of toxic hazards. The amounts of toxins present in foods tend to be uncertain and extremely variable. Hence, new terms, concepts and computation patterns are needed.

THE RISK INDEX. I have found the "Risk Index" to be a useful concept The Risk Index (RI) is defined as the number of servings per week of target foods that one finds in the diet history (12). In this instance the target foods for aflatoxins are: corn, peanuts, rice and milk. Final evaluation also requires some knowledge of the amounts of aflatoxin in the food chain. Using this tool it has been possible to demonstrate (14) a strong relationship ($P<.0001$) between the aflatoxin Risk Index in the diet of the mother and the reduced IQ of the child. This and similar devices must be developed to cope with the toxicity problems of the future.

In this instance, the approach has served to provide a reasonable answer to the conundrum posed by a strong relationship between diet and mental retardation--without any obvious relationship to nutrient intake. I would predict that, as experience increases, the dietitian will become much more interested in food-related toxicants, both "natural" and man-made.

THE FOOD FREQUENCY DIET HISTORY. Now let me digress from this narative to detail some of the methods involved in the Georgia work. These are named in Table I.

TABLE I

METHODS USED WITH FOOD FREQUENCY DIET HISTORIES

Locate Group Eating Habit Patterns
with factor analysis (correlation)

Measure Differences between Groups
with means, standard deviations and t-tests
on food and/or nutrient data

List Core Foods in Relation to Energy/Nutrients

Compute Risk Index related to Toxins

Nutrient Evaluation of Diets

The use of factor analysis in sorting out eating habit patterns was described in 1962 (1). The data came from diet studies carried out in Putney School in Vermont while I was in the Nutrition Branch of the US Public Health Service in 1948. I initially carried out the correlations, factor analysis and other statistical computations by hand methods using pencil and hand calculator. It was some 14 years later, after I had written a factor analysis program for the UNIVAC 1103, that I had a chance to recheck the computations and publish the results. The first step in the computations is to correlate each diet pattern with all of the others. In practice this requires that all foods be listed in the same order-- and, hence, works best with data taken from a set-format questionnaire.

Once the different diet pattern groups are identified it becomes important to see just what it is that distinguishes one group from another--and to do this in foods terms as well as in nutrient terms. This is best accomplished by getting group means and standard deviations food-by-food and nutrient-by-nutrient, and then applying the t-test to each food and nutrient in turn. This is accomplished quite easily with the programs I have written, and the results provide a definitive description of the differences between groups in both foods and nutrient terms. Again, it should be noted that both foods and nutrients in each group must be listed in the same order to make the process work--and this works easily when one uses a fixed-format questionnaire.

The "Core Diet" is a concept that grew out of work with a poverty population in Georgia (2). It was noted that a major part of the total caloric intake was provided by only a few (1-2 dozen) common food items, and that another 40% of the food items (that took 40% of the time and computation effort) provided only 4% of calories or of any nutrient. It was this core of a few foods that largely determined the nutritional status of the individual, and this core was very constant throughout the year and was very resistant to change by non-specific nutrition education efforts. If a dietitian really wants to help modify a person's diet, it is crucial to measure and be aware of the core diet for this individual. Our programs list foods from largest to smallest in terms of the contribution they make to the total caloric intake. The procedures work equally well for any other nutritent or any combination of nutrients. The speed of this operation is largely dependent upon the speed of the printer. Along with each food is given the number of calories or milligrams of nutrient contributed, along with the percentage of the total provided, and a cumulative percentage total. Again, the mechanics of certain steps is simplified if all items are arranged in the same format.

The Risk Index needs very little additional comment. Its computation is quite simple--once you decide on a reasonable basis for that computation.

Finally, we reach the nutritional evaluation of dietary (food) intake data. Too much has already been said about errors and problems related to the nutrient composition table (nutrient data bank), whereas in survey work and other work involving interview data, it may be this latter step that provides the most serious errors (10). Let me instead limit my remarks to the computation procedure. The usual procedure is a slow and cumbersome table look-up procedure. It is slow to enter in the computer and slow in computation. If, however, all foods are entered in some constant order, one avoids the problem of looking up or remembering code numbers and the computation can be accomplished by a single matrix multiplication step--which is extremely fast, particularly if one has the assistance of a coprocessor chip. It should be mentioned that our program is independent of the foods used in the process. Later this morning you will hear a report of work carried out in Benin, West Africa. This uses an international diet table and runs smoothly with our programs (7,8).

HISTORY. We use food frequency diet histories obtained with the use of a fixed format questionnaire designed specifically for the population studied. It would be nice if we could say that we arrived at this on an intellectual basis after pondering all of the considerations listed above. Actually it came as a result of painful trial and error.

One of the initial jobs, about 5 years ago, involved the nutrient evaluation of about 4,000 diet records (24-hour recalls) obtained in 29 counties of the state in an Extension project (5,6). We had one RadioShack TRS-80 Model I and some part-time help to do the job. Once we caught on to the importance of the fixed format approach we were able to enter records at the rate of 6-10/hour, and entered the entire set in 3-4 man-months (more properly, woman-months) of working time. All other computations were programmed to use this disk-file input and run in continuous sequence. Hence, the nutrient evaluations could be run over nights (with a reliable printer) and the longer statistical procedures could be run over the week-ends. County means and staandard deviations representing about 2600 diet records have been published (6).

In parallel with this project, I took a group of trained graduate students into the field to get some food frequency diet histories in similar counties and at the same time as the Extension project was going on. As a result we had two parallel sets of data going through the computer, being evaluated with the same data base. This provided an unusual opportunity to compare two procedures for obtaining dietary intake information by interview methods. A study of these results taught a number of things about getting diet records. These results and this discussion have been published (10).

In the past a major deterrent to the use of the food frequency approach has been the necessity to convert frequency data to grams/day estimates of food intake. This problem has been solved in various ways--some of which were due for discussion in an earlier session. The simplest and most general procedure that we have used has now appeared in the April issue of Nutrition Research (13). It is well adapted to systematic computer operations, and is built into our programs.

FUTURE. I would like to close with a few brief comments about the further problems and directions in this field. Flexibility is a key word, and the number and identity of the foods involved are certainly among the key variables. Some consider that number is no problem--it should be as high as possible (5000 is better than 3000), but they are limited to table look-up computational algorithms. It is when you begin correlation studies that you come to appreciate the distortions and errors (4) associated with a high percentage of null values. Data from nation-wide studies from US (16) and Britain (17) demonstrate that some 99% of the useful information can be obtained with a list of about 150 foods. Since some of these are interrelated (i.e., skim milk, 2% milk, whole milk) or redundant (12 varieties of salt water fish), the lists could be cut with little loss--particularly if follow-up questions are used (13).

With small microcomputers there is some advantage to keeping the number of foods below 128. In work with a fairly homogeneous cultural group, it is common to find that a list with 90-105 foods is quite adequate. In the work to be reported later from Benin, West Africa a group of 62 foods was adequate for the study of several tribal, religious, and cultural groups. In general, malnutrition is associated with a limitation of food choices. If you need more than 100, you may want to rethink your experimental design--or devise several distinct and different data bases to fit the different cultural groups being served. Our programs are designed to be independent of the food list. They have a series of routines to facilitate the modification of food choices.

When the food list is limited to 100-150 items, it becomes quite possible to provide a maximum amount of nutrient information for each food. Furthermore, it becomes easier to provide adequate data on the natural and man-made toxicants that may occur in these foods. I see the interest in toxic materials increasing markedly as we learn more about them.

The next three speakers are all making use of the methods discused here.

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REFERENCES

1. Caster, W.O. Use of a digital computer in the study of eating habit patterns. Am. J. Clin. Nutr. 10:98-106 (1962)

2. Caster, W.O. The core diet of lower-economic class women in Georgia. Ecol. Food Nutr. 9:241-246 (1980); Fed. Proc. 36:1172 (1977)

3. Mihelich, K., J.K. Caldwell and W.O. Caster. Total food intake of older persons enrolled in a delivered lunch program. Fed. Proc. 41:534A (1982)

4. Caster. W.O. The measurement of eating habit patterns. Fed. Proc. 41:534A (1982)

5. Rumps, K.A., W.O. Caster and A.V. Peisher. Effect of a nutrition education program on the diet of homemakers of low-income families. Food group and nutrient intakes. Nutr. Res. 3:271-277 (1982); Fed. Proc. 41:534A (1982)

6. Rumps, K.A., W.O. Caster and A.V. Peisher. Average diet of lower income women in 29 counties of Georgia observed in June, August, October and December 1980. NAPS Document No. 04072. 123 pages. Microfiche Publications, New York, NY (1983)

7. Caster, W. O. Computer use for nutrition majors. J. Nutr. Ed. 16:76G (1984)

8. Caster, W.O. Programs to study and evaluate human diets in both foods and nutrient terms. NAPS Documment No. 04159. 56 pages. Microfiche Publications, New York, NY (1984)

9. Caster, W.O., S.K. Drummond and M.A. Tanner. Maternal diet and mental retardation in southern Georgia, USA. Int. J. Vit. Nutr. Res. 54:371-375 (1984); Fed. Proc. 41:534A (1982)

10. Caster, W.O. A comparison of two methods for obtaining diet records. Nutr. Res. 5:349-354 (1986)

11. Hudy, S.P., W.O. Caster and C.G. Hanes. Changes in food and nutrient intake patterns observed in older men and women in Evans county, Georgia. J. Clin. Exp. Gerontol. 7:99-113 (1985)

12. Caster, W.O. Diet evaluations involving toxicants in foods. J. Rural Health 1:7-8 (1985)

13. Caster, W. O. Systematic estimation of food intakes from food frequency data. Nutr. Res. 6:469-472 (1986)

14. Caster, W.O., T.A. Burton, T.R. Irvin and M.A. Tanner. Dietary aflatoxins, intellegence and school performance in southern Georgia. Internat. J. Vit Nutr. Res. 56: in press (Sept. 1986); Fed. Proc. 45:591 (1986)

15. Sauer, H.I. Vital Health Statistics Ser. 3, No. 18, 1 (1980)

16. Block, G., C.M. Dresser, A.M. Hartman and M.D. Carroll. Nutrient sources in the American diet: Quantitative data from the NHANES II survey. II Macronutrients and fats. Am. J. Epidemiol. 122:27-40 (1985)

17. Ministry of Agriculture, Fisheries and Food. Annual Report of the National Food Survey Committee. HMSO, London.

PROCEEDINGS OF THE 11TH NATIONAL NUTRIENT DATABANK CONFERENCE
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FOOD DETERMINANTS FOR SPECIFIC DIETARY CARBOHYDRATES

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INTRODUCTION

Food macronutrients are conveniently classified into three broad categories which are proteins, lipids, and carbohydrates. These categories are further defined by considering specific chemical constituents. Compilations like Handbook 8 provide listings for specific constituents such as the individual fatty acids in lipids and individual amino acids in proteins. However, in the case of carbohydrates the data are generally listed as total carbohydrates and that value is obtained by difference between the dry matter and the sum of protein, lipids and ash.

With the advent of more rapid and specific analytical procedures like paper chromatography and high performance liquid chromatography (HPLC), publications giving concentrations of specific sugars in foods have become more numerous (1-4, 6, 7).

As is true with any nutrient, there is some difficulty in assigning a specific concentration for a sugar in a food. To illustrate the type of variation in composition one might expect, consider the changes in sugars in cantaloupe flesh as the fruit develops on the vine. Sucrose ranges from 0 to 6 % while glucose and fructose each vary from 1 to 2.5 %. An eating ripe fruit could be expected to have an average composition of 6.0, 1.6, and 1.7 % sucrose, glucose, and fructose, respectively. These values may vary with different cultivars. In spite of these variations, it is possible to assign a workable concentration for specific sugars in an eating ripe fruit. One should never lose sight of the fact that these values are averages and a "best estimate".

In addition to the most commonly occuring sugars, sucrose, glucose, and fructose, current analytical technology allows for rapid determination of other monosaccharides, and oligosaccharides which are carbohydrates that yield from 2 to 9 monosaccharides upon acid hydrolysis. This group of carbohydrates includes stachyose and raffinose. Recent advances in the manipulation of plant morphogenesis implicate oligosaccharides as critical biochemical regulators (8). With findings such as these, it can be expected that even more significant advances in oligosaccharide separations and characterizations will be developed. Although it is speculative, the development of new information about specific oligosaccharides may well lead to an understanding of their role in human physiology.

In work with onions, it has been shown (4, 5) that there are at least 7 fructosans (oligosaccharides containing fructose) ranging in size from 2 to 7 sub-units of fructose.. In a high dry matter onion, carbohydrates comprise over 80 % of the dry matter. The fructosans account for approximately 60 % of the carbohydrates.

As future research elucidates roles for specific simple sugars, oligosaccharides, and polysaccharides, the need for analytical data on these constituents will increase. Clearly, there is a lot of analytical work to do in order to develop a comprehensive data base for specific carbohydrates. The purpose of this presentation is to demonstrate the kinds of data that are available now, and how these data can be used delineate food determinants for specific carbohydrates in specific diets.

RESULTS AND DISCUSSION

The data used in this presentation are are taken from a study on food and nutrient intake patterns of older men and women in Evans County , Georgia. This study has been presented in detail elsewhere (5). In this work it has been possible to look at several categories of carbohydrate intake, which include total carbohydrates, fiber, starch, total sugars, glucose, fructose, sucrose, lactose, and stachyose. For example, it is possible to look at an overall picture like the daily total carbohydrate intake or a specific case like the daily intake of glucose.

It is also possible to analyze the same data to establish which foods determine the major portion of the daily intake of specific sugars. The food consumption patterns were examined in light of high and low consumption of a specific sugar such as glucose. All of the data for the men were arranged in decreasing order according to the amount of the daily glucose intake. Those men in the top quartile were considered high consumers of glucose and those in the bottom quartile were low consumers. The average amount of glucose consumed by the high and low groups was 20.0 and 3.3 g/day, respectively. The foods providing significant amounts of glucose were orange juice, grapefruit and lemonade. Seventy percent of the glucose intake in the high group was derived from these three food sources.

The same food determinant analysis was run for fructose, sucrose, lactose, and stachyose. The high and low fructose intakes were 20.2 and 3.1 grams/day, respectively and are essentially the same as those for glucose. A significant difference occurs in that the major fructose source is apple products. Also, it should be noted that specific fruits (pears and peaches) played a more significant role in supplying fructose. In each of these cases it is noted that those individuals with high intakes of a specific sugar, ingest added amounts of a key food. This should not be taken as implying that their total caloric intake is increased. It is not. All energy intakes in these groups are about the same. As one food increases, another food or group of foods decreases. In part, this is random. In part, however, there are consistent and statistically significant decreases noted in specific foods.

The story with sucrose differs markedly from that for glucose and fructose. The total intake for both groups is higher (107 and 35 grams/day for high and low groups, respectively) and the three major sources are sugar, soft drinks, and candy. These foods are considered to be highly processed products. Even in the low intake group there are small amounts of cookies, cakes, jam, jelly, fruits, and ice cream present. Some of the men, however, seemed to have the proverbial "sweet tooth". They sprinkled more sugar on their foods and had candy and soft drinks for snacks.

The daily lactose intake was 30 and 3 grams for the high and low groups. Obviously, milk sugar comes from milk and milk products. The extremes of intake are noteworthy. A certain minimal amount of milk solids appears in a number of foods--particularly those providing the major amount of lactose in the low group. The big difference between high and low is to be found in the consumption of fluid milk. Some men were "milk drinkers" and others were not. Measuring the lactose intake provides one of the cleanest ways of distinguishing between these groups.

Stachyose is of interest because of its association with flatulence. The intake of stachyose was 0.66 and 0.03 g/day for the high and low groups. The major sources were dried peas and beans.

One of the important things to note was that there were relatively few foods which were consumed in significantly higher amounts by the high group than the low group and in the case of each sugar were considered major food determinants. Those determinant foods were oranges, grapefruit, apples, pears, peaches, sugar, soft drinks, candy, milk, dry peas, and beans. That is 11 foods. When you add to this another list of about 10 foods (beets, turnips, bread, cookies, cakes, jams, jellies, and a few additional fruits and milk products) one has all the foods that provide appreciable amounts of the simple sugars in this older population. This is important to those building and using food tables. One can get a reasonable approximation of any sugar intake with a relatively modest number of foods. Furthermore, the concentration of simple sugars in most of these foods is readily available in the literature. Several references are provided which may help in efforts in this direction.

REFERENCES

1. Birth, G. S., Dull, G. G., Magee, J. B., Chan, H. T., and Cavaletto, C. G. 1984. An Optical Method for Estimating Papaya Maturity. J. Am. Soc. Hort. Sci. 109(1):62-66.

2. Birth, G. S., Dull, G. G., Renfroe, W. T., and Kays, S. J. 1985. Nondestructive Spectrophotometric Determination of Dry Matter in Onions J. Am. Soc. Hort. Sci. 110(2):297-303

3. Darbyshire, B., and Henry, R.J. 1979. The association of fructans with high percentage dry weight onion cultivars suitable for dehydrating. J. Sci. Food Agr. 30:1035-1038.

4. Dull, Gerald G. 1984. Measurement of Cantaloupe Quality With Near Infrared Spectrophotometry. Winter Meeting of Am. Soc. Agric. Eng. Paper No. 84-3557.

5. Hudy, S.P., Caster, W.O. and Hames, C.G. 1985. Changes in Food and Nutrient Intake Patterns Observed in Older Men and Women in Evans County, Georgia. J. Clin. Experimental Geront. 7(2):99-113.

6. Lee, C. Y., Shallenberger, R. S. and Vittum, M. T. 1970. Free sugars in fruits and vegetables. New York State Agric. Expt. Sta., Geneva. New York's Food and Life Sciences Bulletin No. 1, p 1 - 12.

7. Meredith, F.I., Thomas, Charles A. and Heggestad, Howard E. 1986 Effect of the Pollutant Ozone in Ambient Air on Lima Beans. J. Agr. Food Chem. 34(2):179-185.

8. Van, Kiem Tran Thanh, Patrick Toubart, Alain Cousson, Alan G. Darvill, David J. Gollin, Paulanne Chelf, Peter Albersheim. 1985 Manipulation of the morphogenetic pathways of tobacco explants by oligosaccharins. Nature. 314:615-617.

DIFFERENCES IN DIETS OF MOTHERS OF PRESCHOOL CHILDREN FROM TWO INCOME GROUPS

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INTRODUCTION

Studies concerning family influences on the dietary patterns of young children provide a basis for educators in the development of effective programs for better nutrition. The family, and mothers in particular, affect children's dietary practices, directly through the provision of food and indirectly through influences on attitudes and preferences for food. Food preferences established early in life are likely to continue throughout the life span.

The purpose of this study was to determine differences in food consumption patterns of mothers of preschool children from two income groups. Specific objectives were to:

1. Determine differences in nutrient intake of mothers of preschool children from low (LI) and middle income (MI) families.
2. Determine differences in food consumption patterns of mothers from two income groups.
3. Determine relationships between food intake of mothers and reported consumption of food by their preschool children.

METHODS

The subjects were mothers of pre-school children enrolled in area preschool programs. Two groups of mothers representing low income (LI) and middle income (MI) families were selected for the study. A total of 36 mothers participated in the study, 13 represented the LI group and 23 represented the MI group.

The questionnaire was designed to be self-administered. However, subjects were informed to contact investigators for assistance, if needed, in completing the questionnaires. A family inventory, questions on family income, and food and nutrition practices of the mother were included in the questionnaire. In addition, a food frequency section, adapted from diet history questionnaires used in several studies in Georgia (1,2) was included. Mothers were likewise asked to report on their child's frequency of consumption of eight food groups including milk and cheese, vegetables, fruit, meat, eggs, breads and cereals, and desserts and snacks.

Nutrient Intakes and core diets (3) and statistical evaluations were performed with the aid of published (4) microcomputer programs. Pearson product correlation coefficients between food intakes of mothers and reported consumption of eight food groups by children were determined (5).

RESULTS

Mothers in the MI group were predominantly (95%) white, while those in the LI group were predominantly (63%) black. The MI mothers had a significantly higher ($P < 0.01$) average age of 33 years than the LI mothers who had an average age of 29 years. Education of mothers from the MI group was significantly higher ($P < 0.001$) than that from the LI group. The MI mothers either had some college education or a college degree while LI mothers either had some high school education, or completed high school. The mean annual family income of the MI mothers was in the $20,000 - $29,000 range while that in the LI group was under $9,999. The difference in income was significant at the $P < 0.0001$ level.

Table 1 shows the computed intake of most major nutrients by the LI and MI mothers. Mean values are given for both groups with a pooled estimate of the standard deviation. No major differences were found in the nutrient intake of mothers in the two groups. Only fiber intake was found to be significantly higher in diets of mothers from the MI group, while selenium was higher in the LI group. The nutrient intakes found in this study are within the range of values reported by Caster et al. (2) on diets of mothers of children used as the control group in studies conducted in Georgia.

TABLE 1
Differences Between Nutrient Intakes of Mothers of Preschool From Low (LI) and Middle Income (MI) Groups.

Food	Nutrient Intake		Standard	
	LI	MI	Deviation	t-test
Energy (Kcal)	2420	2190	842	.81
Protein (g)	92	78	38	1.05
Lipid (g)	113	93	46	1.27
Fiber (g)	4.0	5.8	2.7	2.00*
Sugar (g)	140	125	47.6	.91
Calcium (mg)	811	903	452	.59
Sodium (g)	3.7	3.3	1.6	.69
Iron (mg)	11.9	11.4	5.0	.29
Copper (mg)	2.4	1.9	1.3	1.03
Zinc (mg)	12.6	11.8	5.2	.49
Selenium (mcg)	28.3	18.0	14.1	2.09*
Vit C (mg)	123	131	81	.28
Vit B-1 (mg)	1.5	1.4	.79	.23
Vit B-6 (mg)	2.6	2.4	1.4	.45
Folate (ug)	221	246	111	.66
Vit A (I. U.)	14700	18000	14200	.59

*$0.05 > P > 0.01$

Average daily energy intake calculated from diets of the 36 mothers was 2270 Kcalories, with 39.8% of energy from fat and 14.5% from protein. Sugar provided 51% of the 260 g of carbohydrate in the diet. Cholesterol intake was 404 mg. Average daily intake of folacin, pantothenate, magnesium, iron, zinc, manganese and selenium were lower than the recommended dietary allowances (6) for these nutrients.

While microcomputer nutrient analysis of mothers' diets, indicated no differences between groups, major differences were found in the food consumption patterns of mothers in the two groups. A list of the food consumed by the LI mothers in quantities significantly different from that of the MI mothers is shown in Table 2. Low income mothers consumed more liver and organ meats, and cured meats in the form of sausage, bacon and frankfurters. Chicken was consumed by LI mothers in fried form as opposed to the stewed forms consumed by MI mothers. Among the vegetables listed in the questionnaire, more beets or turnips, corn and okra were consumed by low income mothers, while middle income mothers ate more vegetable casseroles, lettuce salad and tomatoes. In addition, more cottage cheese,and vegetable oils and mayonnaise were consumed by MI mothers. More cornbread and corn grits were consumed by the low income mothers. Low income mothers consumed more white bread, while more dark breads were consumed by middle income mothers. Pudding and grapefruit were also consumed in greater quantities by the LI mothers.

TABLE 2
Differences Between Diets of Mothers of Preschool Children From Low (LI) and Middle Income (MI) Groups.

Food	Food Intake (g) LI	Difference of from MI	Standard Deviation	t-test
Coffee	106	-143	178	2.31*
Liver/Organ Meat	13	12	16	2.03*
Sausage	20	17	13	3.79**
Bacon	6	4	5	2.35*
Chicken, Stewed	8	-15	17	2.57*
Chicken, Fried	32	28	26	3.07**
Luncheon Meats	14	8	11	2.18*
Hot Dogs/Frankfurters	10	5	6	2.38*
Cottage cheese	2	-17	22	2.16*
Grapefruit	44	35	34	2.93**
Beets/Turnips	12	10	12	2.46*
Corn	20	8	8	2.83**
Lettuce Salad	14	-26	21	3.51**
Tomato	13	-27	30	2.51*
Cornbread	35	28	22	3.72***

continued

TABLE 2 (continued)

Food	Food Intake (g) Difference of LI	from MI	Standard Deviation	t-test
Bread, White	51	32	29	3.20**
Bread, Dark	6	-23	23	2.85**
Corn Grits	24	16	16	2.89**
Vegetable Casserole	2	-35	33	3.04**
Pudding	15	11	15	2.13*
Margarine	38	21	27	2.25*
Vegetable Oil/Mayonnaise	4	-4	4	2.85**
Port Fat	1.3	0.8	0.9	2.61*
Okra	19	14	20	2.00*

*0.05 > P > 0.01
**P < 0.01
***P < 0.001

Foods that contributed up to 50% of the energy intake of both groups of mothers are ranked in Table 3, along with percent contribution. Only 12 foods contributed to 50% of the energy intake of the LI mothers while 15 foods contributed to that of the MI mothers. Margarine provided the greatest energy contribution in diets of mothers in both LI and MI groups, but while it contributed 10.7 percent of the energy intake of LI mothers, it provided only 5.8 percent of the energy intake of MI mothers. The second to the fifth ranked foods of the MI mothers appeared to consist of more nutrient dense foods such as cheese, peanuts and peanut butter, cold cereals and milk, while that of the LI mothers consisted of white bread, soft drinks, lemonade or punch, and sugar which appear to be more calorie dense foods.

Intake of sugars was not significantly different for the two groups. For both groups, soft drinks, lemonade or punch and sugar were the three items that made the greatest percentage contribution to dietary sugars. The main difference was that in the LI mothers group, these three foods contributed 58.3 percent of sugars in the diet while in the MI group, these contributed only 34.6% of the sugars in the diet.

One of two differences between diets of LI and MI mothers was fiber intake. Only 8 foods in the MI mothers diet contributed 50 percent of the fiber in the diet while in the LI mothers diets 12 foods contributed to 50 percent of the fiber. Table 3 ranks the foods that contribute to 50 percent of the fiber in diets of mothers from LI and MI families. The percent contribution of each food to the fiber intake is likewise listed. Corn and vegetable casseroles provided the greatest contribution of fiber to the diets of LI and MI mothers, respectively. Apples and dried beans and peas contributed substantially to diets of both groups of mothers.

TABLE 3
Foods Ranked According to Percent Contribution to Energy Intake.

Food	Rank LI	%	Rank MI	%
Margarine	1	10.7	1	5.8
Bread, White	2	5.4	13	2.4
Soft Drinks	3	5.2	12	2.8
Lemonade/Punch	4	5.0		
Sugar	5	4.7	11	2.8
Chicken, Fried	6	3.1		
Ice Cream/Milk	7	2.8		
Sausage	8	2.8		
Cornbread	9	2.7		
Milk (Skim)	10	2.7	5	3.5
Peanuts/Peanut Butter	11	2.3	3	4.1
Cheese	12	2.3	2	5.3
Cereals, Cold	-		4	4.0
Cookies/Cake	-		6	3.2
Bread, Dark	-		7	3.2
Vegetable Oil/Mayonnaise	-		8	3.1
Chicken, Stewed	-		9	3.0
Butter	-		10	3.0
Biscuit/Rolls	-		14	2.1
Egg	-		15	2.1
TOTAL		50.0		50.4

TABLE 4
Foods Ranked According to Percent Contribution to Fiber Intake.

Food	Rank LI	%	Rank MI	%
Corn	1	6.5	-	
Apples/Applesauce	2	6.5	2	8.2
Dried Peas/Beans	3	5.6	3	8.1
Okra	4	4.5	-	
Cornbread	5	4.4	-	
Peas, Green	6	4.0	-	
Peanuts/Peanut Butter	7	4.0	8	4.0
Peaches	8	4.0	6	5.3

continued

TABLE 4 (continued)

Food	Rank LI	%	MI	%
Banana	9	3.2	-	
Carrots	10	3.1	5	5.5
Cabbage/Slaw	11	3.1	-	
Melons	12	2.7	-	
Vegetable Casserole	-		1	8.2
Bread, Dark	-		4	8.0
Broccoli	-		7	4.2
TOTAL		51.3		51.3

The children's frequency of consumption of 8 groups of food as reported by their mothers are listed in Table 5. Significant differences between the LI and the MI groups were found in the children's reported consumption of milk and cheese ($P < 0.02$), fruit ($P < 0.05$) and breads and cereal ($P < 0.01$). Preschool children from the MI groups consumed more milk and cheese, fruit, and breads and cereals than those in the LI group. The reported consumption of vegetables, meat, eggs, desserts and snacks was not different in the two groups.

TABLE 5
Reported Frequency of Consumption of Food by Children from Two Socioeconomic Levels (per month).

	low I	middle II	t	P <
milk and cheese	56.2	80.4	2.72	.02
vegetables	44.84	51.60		NS[a]
fruit	35.05	55.20	2.41	.05
meat	45.47	42.92		NS
eggs	20.21	15.12		NS
bread and cereal	49.32	79.20	2.71	.01
desserts	18.79	32.68		NS
snacks	41.37	57.64		NS

[a]NS = Not significant

Pearson product correlation coefficients were obtained between the foods consumed by mothers and the reported consumption of 8 groups of food by preschool children. These are listed in Table 6. While the magnitude of the correlation coefficients are low, they nevertheless indicate significant relationships between diets of mothers and the reported consumption of food by preschool children.

TABLE 6
Pearson Product Correlation Coefficients Between Foods in Mother's and Children's Diets

	Child's diet				
Mother's diet	Vegetables	Fruit	Meat	Dessert	Snacks
Carrots	.32*				
Tomato, tomato juice	.45**				
Peas, green	.38*				
Watermelon, honey dew, cantaloupe		.48***			
Peaches, fresh		.48***			
Pears, fresh		.47**			
Berries, blue, straw		.39**			
Plums, grapes, grape juice		.34*			
Banana		.45**			.35*
Beef roast			.42**		
Luncheon meat			.36*		
Ice cream, ice milk				.31*	.30*
Salty snack					.33*

*P < .05
**P < .01
***P < .001

SUMMARY AND CONCLUSIONS

The results of this study indicate that the lack of major differences in the nutrient intake of mothers of preschool children from low and middle income groups. However, several differences exist in the types of food consumed by mothers in the two groups. Differences likewise exist in the reported consumption of 8 food groups by preschool children. Relationships between items in the mothers diets and reported consumption of 8 food groups by preschool children were found.

REFERENCES

1. Caster, W. O. A comparison of two methods for obtaining dietary intake data. Nutr. Res. 5:349-354, 1985.

2. Caster, W. O., Drummond, S. K. and Tanner, M. A. Maternal diet and mental retardation in southern Georgia, USA. Int. J. Vit. and Nutr. Res. 54:371-375, 1984.

3. Caster, W. O. The core diet of lower-class women in Georgia. Ecol. Food Nutr. 9:241-246, 1980.

4. Caster, W. O. Programs to study and evaluate human diets in both foods and nutrient terms. NAPS Document No. 04159, Microfiche Publications, New York, pp 58, 1984.

5. SAS Institute, Inc., SAS User's Guide: Statistics. Cary, NC: SAS Institute, Inc., 1982.

6. National Research Council, Recommended Dietary Allowances, Ninth Revised Edition. National Academy of Sciences, Washington, D.C., 1980.

CULTURAL DIET PATTERNS IN BENIN, WEST AFRICA

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BENIN. Benin (also known as Dahomey) is a country about the size of Tennessee, with a population of three million. It is located on the West coast of Africa, a few degrees above the Equator. It is home to more than 20 distinct ethnic groups, speaking more than 15 major languages (1). An independent nation since 1960, Benin was formerly a provence of French West Africa. A strong French influence continues to permeate political organization, economic ties, sociocultural life, and the direction of development within the country (2). The economy of Benin is predominantly agricultural, though staples and other crops vary between three distict environmental zones (3) that change from equatorial on the coast to tropical in the North. In northern Benin, millet, sorghum and corn are staple crops. In the central region major foods are yams, cassava, and plantains. In the southern costal region there are a wide variety of crops, including yams, cassava, rice, beans and corn. Throughout the country, on a seasonal basis, other fruits and vegetables are available, and in places milk and cheese can be obtained.

If you take the train from the coast, some 400 miles to the northern end of the line, you arrive at Parakou--a city of 60,000 that is the political, commercial and economic center of the Provence of Atakora. It is subject to a variety of cultural influences (4), and its markets provide a wide selection of foods and other trade goods. Although precise figures on the distribution of cultural groups in Parakou are not available, it is known that the Bariba and the Dendi comprise a majority of the population. The casual visitor might note that a great majority of adults are illiterate and could claim little formal education. A second look however would show that most speak two languages and some are fluent in 5-6 languages. There are deeply ingrained patterns of belief and performance that pervade all aspects of life. Without a clear understanding of these, one can have little hope of understanding eating habit patterns. For example, many are Moslem--and, as you might expect, do not eat pork.

DIET RECORDS. Now, let us turn to a note on methodology. A frequent pattern, advocated by some beginning nutritionists, is to send a scientist in to a community to work for 2-3 weeks and get a sample of diet records to use for nutritional evaluation purposes. Since the scientist does not speak the language, arrangements are made for a translator to use in getting the diet records.

To picture the nature of some of the problems involved, let us reverse the situation for a moment. Let us assume that a scientist from Benin was sent to south Georgia to study the relationship between diet and some of the known health problems of this area. Let us further assume that this foreign scientist did not understand English--but had found a local person that spoke both English and one of the six languages known to him. The translator, the wife of the local Baptist preacher, had spent some time in the mission field, and thus had some limited linguistic ability. Now, let us go to the first home and introduce everyone. The family happens to be one of the staunch supporters of the Baptist church. The scientist pulls out his questionnaire and asks the first question -"How frequently do you drink beer? wine? and whiskey?" Well, the translator now has a problem. Her husband constantly preaches on the evils of alcohol and is leading a movement to vote the county "dry"--and this family is a prime supporter of the church. What to do! The scientist will disappear in two weeks, but she must live and work with this family for some years! So, in English, she asks "What do you usually drink with your meals?", and reports to the scientist that they never drink beer, wine or whiskey, but frequently have ice tea or coca cola with meals. Now, all of this may or may not be the total truth--but it helps to demonstrate some of the hazards involved in getting diet records by relying on translators. Much can be lost in the "translation", and even more importantly, many crucial questions are not asked because the visitor does not have the insight required to ask them.

In saying all of this, it should also be mentioned that help and assistance from local collaborators is a practical necessity. Success requires not only some knowledge of nutrition but, above all, a clear understanding of the local language and culture (5-7). Okere (8), an Igbo working among the Igbo of Nigeria, describes some of the problems of diet research he encountered. For a non-African, the problems multiply. The researcher must gain the trust of the community, become as fluent as possible in the languages of the area, be able to establish rapport with informants, and cope with the ethnic problems of field work. Like Okere, I had to deal with the problem that most Parakou residents initially see anyone with papers in hand as a government representative--probably a tax collector. In order to gather accurate data, I had to convince them that it would not be used for tax assessment. A related problem, encountered early in the study period, was that of respondents tending to under-report their diet in the hope that "the wealth American" would give them money to help supplement their obviously inadequate diet. This feeling was further complicated with local etiquette that demanded that any "visitor" present some form of gift. On the other hand I was faced with certain economic realities and problems of professional ethics. A certain amount of finesse was necessary to elicit data that seemed reasonable--when evaluated in terms of the material goods visible within the home. My Beninese assistants were often useful in providing me with inside information about the family, and helping me to evaluate the accuracy of the information that we had obtained.

One could pursue other aspects of this topic, but let me jump to the process that I used. I do not pretend that it is perfect, but after a little experimentation with translators, this is what I turned to. First of all I learned enough of some of the major languages that I could converse after a fashion. Then, I moved into the community and got acquainted. I visited the home and kitchens during food preparation, and ate with them. At my home I had a collection of bowls and containers, plus a small spring scales. So I rushed home, repeated the food preparation and wrote down the serving sizes and ingredient weights. After a little experience of this type I felt that I could get reasonable diet histories that reported both the identity of the foods consumed and the serving sizes involved.

NUTRIENTS AND FOOD PATTERNS. Once I had the diet records in hand, I still had a number of serious problems ahead before I could evaluate the records and organize the data for interpretation by health and cultural groups. I do not have to detail for this group the needs for detailed international diet tables giving the nutrient composition of the various foods. Before I am through, However, I may want to add some footnotes to this topic.

To give some perspective on this matter, let me jump to the presentation of some of the core diet data that relates food data to nutrient data. The major part of the energy intake comes from: yams (pounded, boiled and fried), koko, dibu, beef, fried cakes, wasa wasa, pate de mais, manioc, ragout, akassa, rice, pasta and a group of gravies or sauces. We will talk more about some of these foods in a moment. Much of the diet resembles mush or gruel, and are based on specific grains. The gruel or porridge based on corn are koko and pate de mais. The one based on millet is called dibu or pate de mil. Sorgho is based on sorghum grain. The Bariba are typically known as millet eaters, and dibu is a substantial part of the diet. Between the yams and grain, the diet is decidedly starchy.

CARBOHYDRATES. When one looks at the list of foods providing the major part of the carbohydrate, therefore, it is not surprising that the list is very much the same as that see for energy--except, of course, for beef. During the interview, many subjects identified yams and millet as "the true food of the Bariba" and as the foods that their parents and grandparents in the villeges ate exclusively. Despite the introduction of other foods into the diet, these two staples of the "traditional" diet endure in the hearts and kitchens of Parakou. Note that this yam is a white tuber, quite different from the yellow-orange sweet potato of southeastern USA.

The appearance of manioc in several forms in the diet is consistent with the general trend in West Africa for manioc to replace other tubers (10,15). Imported from Brazil around 1500, manioc grows in poor soil and yields a larger crop than some other tubers indigenous to the area. In Parakou, manioc appears in the form of wasa wasa (a greasy processed snack), as gari (a dry form), and as manioc flour that is added as a thickening agent to some gruels. Tapioca could be bought in the market but was rarely mentioned by Bariba or Dendi subjects as a diet item. Manioc is nutritionally inferior to yams, providing little but calories. The production of manioc in Benin now exceeds that of the yam (1) and in Nigeria it is second to the yam (8).

FAT. Fat comes from various sources. Beef is a major contributor, as are the fried foods: fried cakes and fried yams. The guyant, gombo, friture and senri are gravies and/or sauces used on other foods. Wasa wasa is an oily snack food made with manioc. In general, the subjects did not consider snack items as "real" food. In 24 hour-recalls they were routinely missed. The food frequency questionnaire, use at the same time, picked up these items consistently. This is in accord with other experience (11) with these tools. The ability to measure the intake of snacks (such as wasa wasa, fried cakes, gari and fried yams) is important because they can provide an appreciable part of the total caloric intake.

PROTEIN. The list of protein foods is led by beef and is followed by a series of grain-based foods. The fromage peul is a local fulani cheese. Other animal protein sources are eggs, fish and poultry. Milk occurs in various forms, including yogurt. curdled milk, powdered milk, partially evaporated milk and sweetened condensed milk. Pork is not a major food in this largely Moslem land.

The impact of Western foods on non-Western urban residents has been discussed widely in the literature (9,12-14). During the observation phase of the study, numerous Western foods were found in Parakou, and some of these items were included in the food frequency questionnaire. A few of these (such as macaroni, rice, coffee, white bread, green beans and salad) were found to be significant in urban populations but were either unknown or considered "foreign" and not appropriate food items in rural settings.

A special footnote is needed here in relation to koko. This is primarily a corn gruel with a variable composition. The nutrient values shown here are for the product made up with milk. This is significant. As we have looked over the nutrient composition of most diets, one would say that they are generally pretty good. They meet the RDA values fairly well--except for calcium and riboflavin. There are few sources of milk in the diet. Here it becomes important to look at the way koko is made up, and at the corresponding nutrient composition. Unfortunately, when one looks in areas with marked malnutrition, it is found that koko is a major diet component--but here the koko is made with water and with little or no milk. The food has the same name, but the composition is highly dependent upon the economic status of the household.

Now, it may be appropriate to call attention to one hazard encountered in the casual inquiry about food recipes. When you ask a local person for the ingredients and proportions required to make koko you are, in effect, asking for a statement concerning the person's status in the community. There may be a strong tendency to come out with an idealized recipe that could be very misleading when used as a basis for nutritional evaluation. Foods with the same names but different composition can also be misleading in the evaluation of diets on a foods basis--and in the search for distinct eating habit patterns.

The factor analysis plot shown here shows the different ethnic groups represented in this subsample. B indicates Bariba. D is for Dendi. And F is for Fon, a lesser ethnic group. Both the Bariba and Dendi, presumably, have their own characteristic and traditional diets. Here it appears in this urban setting that the diets are largely indistinguishable. Examination of individual diet records confirm that there are Bariba subjects eating predominantly millet. However, others are predominatetly corn eaters. Most eat both. Hence, whatever differences may have been observed in rural villages, once they moved to the city their habits changed and their choices broadend. The one distinct group is the Fon. Only two are represented in this sample, but the differences are statistically significant.

The Fon are different in culture, diet and religon. They are best known in this country due to the fact that they brought voodoo with them when they were imported as slaves into the West Indies. A small number migrated into Atakora from south Benin, and they constitute one of the minor ethnic groups in Parakou. Here we see that their diet differs from the average in that they eat corn but very little millet. They eat pork and more green peas and condensed milk than the general population.

Other groups stand out in a similar fashion, and their dietary differences can be characterized using the t-test. For example, there is a small Christian community and their mean diet differs in that they also eat more corn than millet (dibu). They eat more fresh fish and pineapple, but less boiled yam and curdled milk. Another comparison showed that one group of trades-people had a diet that differed from the mean in that they ate more ragout, more mangoes and more wasa wasa. Currently we are working on health data relating the diet of the mothers to the health of their infants. The computer tools are available, but the health data from Benin are a little slow in arriving.

SUMMARY. In summary, we have taken a brief look at a diet study carried out in a distant land and under conditions that are somewhat beyond those routinely encountered in this country. I have emphasized methodology rather than results or experimental design because I believe that some of the problems and insights discussed here may have general utility and applicability in many situations. I think I will reserve further comment for the question period.

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REFERENCES

1. Adam, K.S. and Boko, M. Le Benin, Paris, EDICEF, 1983.

2. Ronen, D. Dahomey: Between Tradition and Modernity. Ithica: Cornell University Press, 1975

3. May, J. and D.L. McLellan. The Ecology of Malnutrition in the French-Speaking Countries of West Africa and Madagascar. New York: Hafner Publ. Co., 1968

4. Lombard, J. Structures de Type "Feodal" en Afrique Noire. Paris: Mouton and Company, 1965.

5. Wilson, C.S. Developing methods for studying diet ethnographically. In E.E. Bauwens, ed., The Anthropology of Health. St Louis, Mo.: The C.V. Mosby Company, 1978.

6. Jerome, N.W., G.H. Pelto and R.F. Kandell. An ecological approach to nutritional anthropolgy. In Jerome, N.W., G.H. Pelto and R.F. Kandell, Nutritional Anthropology. Pleasantville, N.Y.: Belgrave Publishing Company, 1980.

7. Foster, G.M. and B.A. Anderson. Medical Anthropology, New York: John Wiley and Sons, 1978.

8. Okere, I.C. The Anthropology of Food in Rural Igboland, Nigeria. Lanham, Md.: University Press of America, 1983.

9. Ifekwunigwe, A. Health and nutrition in urban areas. In J. Mayer and J. Dwyer, eds., Food and Nutrition Policy in a Changing World. New York: Oxford niversity Press, 1979.

10. Jones, W.O. Manioc in Africa. Stanford University Press, 1959.

11. Caster, W.O. A comparison of two methods for obtaining dietary intake data. Nutr. Res. 5:349-354, 1985.

12. de Garine, I. Food, nutrition and urbanization. FAO Nutrition Newsletter 7(1): 1-19, 1969.

13. Jelliffe, D.B. Commerciogenic malnutrition. Nutrition Reviews 30(9): 199-205, 1972.

14. Sai, F.T. Nutrition in Ghana. In Winhoff, ed., Nutrition and National Policy. Cambridge, Mass.: The MIT Press, 1978.

15. Latham, M.C. Human Nutrition in Tropical Africa. Rome: FAO, 1979.

PROCEEDINGS OF THE 11TH NATIONAL NUTRIENT DATABANK CONFERENCE
Georgia Center for Continuing Education
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MEETING THE NEEDS OF THE FUTURE
IN DIET AND HEALTH RESEARCH

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In November 1985, the National Academy of Sciences signed a three year contract for approximately two million dollars to establish a Committee on Diet and Health as part of the Food and Nutrition Board.

An initial charge to the Committee was the development of criteria for evaluating the evidence linking diet to health maintenance and reduction of risk of chronic diseases. The Committee was also asked to attempt to formulate dietary guidelines for reducing the risk of chronic diseases, propose strategies for implementing these guidelines and identify areas for futher research.

Concurrent with this activity of the National Academy of Sciences, the International Life Sciences Institute - Nutrition Foundation (ILSI-NF) planned a symposium, scheduled for October of 1986, entitled "Diet and Health: Concepts and Principles". The ILSI-NF symposium will review contemporary dietary patterns and health status with the intent of defining a series of dietary recommendations that can be translated into food selections while maximizing health status.

Many of you are aware of a recent request for proposal (RFP) issued June 17 by the USDA, to study factors affecting dietary status as measured in the continuing survey of food intake of individuals (CSF II-85). The scope of effort identified by this RFP includes personal, demographic and household factors that affect the intake of foods, food groups and nutrients that may in turn determine associated health-related factors.

The proposal allows for study of methodological factors that affect measurement of dietary status. These include techniques for dietary surveys and the influence of eating patterns on nutrient intake.

In reflecting upon my assignment for today, it became evident that I was to accomplish in 30 minutes what one committee will take three years to accomplish, what one international symposium will attempt to achieve in three days and what the USDA will do with contracts totalling $600,000 in 18 months.

Dietary standards have evolved over the past 235 years from the reports by Lind in 1753 on the prevention of scurvy with citrus fruit through standards set during World Wars I and II for feeding members of the armed forces and other nationals. The Recommended Dietary Allowances or RDA's established by the Food and Nutrition Board in 1943 were intended as a "guide for planning and procuring food supplies for national defense". By 1980 the RDA represented an effort to define levels of intake of essential nutrients adequate to meet the nutritional needs of practically all health persons.

While the 1985 Committee on Dietary Allowances was able to reach agreement on the RDA's to be proposed for the Tenth Edition of this publication, this report was not accepted by the Food and Nutrition Board or the National Research Council (2). Failure to define the concept of "requirement for what" was partially responsible for lack of agreement among these groups. It is obvious that interpretations of dietary intake data in relation to estimated requirements required consideraton of the particular biochemical, physical, clinical or functional criteria used to establish requirement.

In 1958, Dr. Charles May upon acceptance of The Borden Award from the American Academy of Pediatrics addressed the question of optimal nutrition (3). He posed the question of: "Do we seek the best diet for material achievement - through maximal growth (size), freedom from disease (health), postponement of death (longevity), fitness for work and war (strength and endurance), survival (reproduction)? Or do we have more concern for the relation of diet to cultural achievement - through function of the mind (thought), behavior (social relations), emotional well being (happiness)?"

Dr. May suggested that "the preoccupations of scientific nutritionists at any one time may be directed as much by the limitations of available techniques as by current concepts or attitudes."

The elusive nature of optimal nutrition remains undefined, 30 years after Dr. May's provocative challenge. There are those in society who opt for freedom from disease, those who desire fitness, those concerned with neurobehavior and others seeking happiness. The number of books on Diet and Nutrition that promise means for achieving the various goals of health, longevity, happiness or endurance attest to the fact that the state of optimal nutrition continues to elude us in spite of an exploding data base that has identified additional essential nutrients (selenium, chromium, vanadium), improved food compostition tables, computers capable of handling large informational loads, new analytical approaches (HPLC, radioimmunoassays) and improved techniques for epidemilogic and genetic studies.

Advances in biotechnology that will result in genetically altered plant and animal products for human use will make our current food composition nutrient data base obsolete. In a recent supplement to the Journal of Animal Science entitled <u>An Assessment of The Role of Meat in Diet/Health Issues</u>, Dr. Guarth Hansen of Utah State University cautioned about seeking simple solutions to complex health problems (4). Hansen is concerned that in so doing, nutritional misconceptions threaten to undermine the improved health we have only recently gained.

A recent symposium organized in part by ILSI-NF on the relationship of dietary energy and fat intake to cancer emphasized the complexity of drawing conclusions about the relationship of dietary fat intake to incidence of breast cancer (5). Most if not all epidemiological studies have failed to consider the effect of total energy intake on body size, obesity, the dietary source of energy i.e. calories from fat, carbohydrates or protein, the fatty acid composition of ingested fat, polyunsaturated verses saturated fats or the role of body fat stores in controlling the production of hormones such as estrogen. Dr. William DeWys of NCI addressed some of these issues in a recent overview of cancer risk factors of dietary origin (6).

More emphasis needs to be placed upon total diet composition rather that individual foods in our efforts to resolve diet-related disease problems and risk statements relating diet to health must be based upon unbiased evluation of the scientific facts.

The subcommittee on Criteria for Dietary Evaluation of the Coordinating Committee on Evaluation of Food Consumption Surveys recently recommended the development of nutrient requirements based on multiple criteria of adequacy (7). For a given nutrient, one might focus on the intake adequate to prevent clinical deficiency, to maintain functional integrity of metabolic systems or to maintain tissue stores. Such definitions would permit multitiered population assessments. In many respects this resembles the efforts to define optimal nutrition as described by May 30 years ago.

Each of us is acutely aware of the increasing complexity of our food supply. The limited number of processed and fresh foods available at the turn of the century has been multiplied many fold so that today's consumer selects from a variety of foodstuffs presented in a variety of processed forms. To further compound the problem more meals are being eaten out of home i.e. within the work place, the school system, in restaurants whether fast food or conventional. We need accurate food composition tables that are commensurate with the wide variety of foods eaten so that nutrient intake can be adequately assessed.

Specifically we need to improve our analytical methods for quantification of vitamin A, carotenoids, vitamin B_{12}, vitamin C and folacin in foods. These nutrients have been implicated in major public health problems such as cancer and anemia. Unless the nutrient data base is accurate little purpose is served by attempts to relate dietary intake of these nutrients to health status.

Major environmental variables that influence nutrient requirements need further study. One such example is the importance of sunlight exposure in the determination of vitamin D requirement.

On the down side of compounds in foods it seems desirable to list those substances such as heavy metals that are known to affect human health. Thirty years ago federal and state agencies were concerned about the health effects of radionuclides in contaminating our food and water supply as the result of atmospheric testing of nuclear devices. Elaborate monitoring systems were in place so that appropriate counter measures could be undertaken (8). The recent experiences in Chernobyl has triggered this system again.

It is reassuring to note that if the nutrient data base contains accurate information on food composition an increase in the number of foods included in the diet record can be shown to decrease the relative variance of total intake estimate (7).

It is sobering to reflect on a report by Kent Stewart who examined the 42 USDA Food Categories and classified them according to the percent of foods in their respective categories for which substantial analytical data exist. Total protein content in a substantial number of foods was known for 82 per cent of the 42 food categories (9). For calcium, iron, zinc, magnesium, sodium, potassium, phosphorous, and cholesterol, these values ranged from 40 to 46 per cent.

Knowledge of copper and fatty acid content was limited to 34 to 37 per cent of the 42 food categories and vitamin A and B_6 content a mere 20 to 27 per cent.

Efforts to relate diet to health will be hampered as long as there is:

* A substantital number of foods for which nutrient values are missing.
* A lack of inexpensive and rapid analytical methods to measure certain key nutrients such as vitamin A, carotenoids, folacin and vitamin C that appear related to public health problems.
* An inability to agree on a definition of "requirements for what" or optimal nutrition.
* A food supply that is increasing in complexity that includes changes in processing, packaging and genetic alterations.
* Failure to increase understanding of the potential for nutrient-nutrient interaction that may influence nutrient bioavailability or requirement.
* Failure to appreciate the need for assessment of total diet rather than specific nutrient effects.
* Continuing changes in eating patterns.
* An attempt to resolve the interaction of diet to health on the basis of consensus rather than the scientific process.

It will require an investment of monies on the part of federal and state governments, the private sector and academia, to meet the needs of the future in diet and health research.

REFERENCES

1. National Academy of Sciences, Recommended Dietary Allowances, Ninth Edition, National Academy of Sciences, Washington D.C., 1980 p.1.

2. Letters to the Editor, Science 230:1324-1327, 1985.

3. C.D. May, Pediatrics 1959.

4. Hansen, R.G., Windham, C.T., Wittwer C.T., and Wyse B.W. Placing the Role of Meat in Human Nutrition in Perspective J. Animal Science 62: Supplement 1, 7 1986.

5. Symposium on Energy and Fat Intake to Cancer to be published Ann J. Clin. Nutrition.

6. DeWys W.D. An Overview of Cancer Risk Factors of Dietary Origin. J. Animal Science 62: Supplement 1, 21, 1986.

7. Subcommittee on Criteria for Dietary Evaluation, Nutrient Adequacy, Assessment Using Food Consumption Surveys, National Academy Press, 1986.

8. Supplement to Pediatrics 60:1968.

9. Stewart K.K. Nutrient Analysis of Food: A Review and a Strategy for the Future In Beecher G.R. (Ed.) Beltsville Symposium in Agricultural Research 4. Human Nutrition Research, Totowa N.J., Allenheld, Osmun and Co. 1981, pp 209-220.

NEW USERS ORIENTATION TO DATABASE TECHNOLOGY:

EVALUATING THE SOFTWARE

HARDWARE CONSIDERATIONS

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The first consideration when buying hardware is - what does your software need. BUY YOUR SOFTWARE FIRST because in order to work, the hardware must be compatible with the software.

In evaluating hardware, the old adage "You get what you pay for" holds true. Cost in hardware is affected by:

capacity - how much can it handle/how big
speed - how fast is it
reliability - service, reputation, brandname and other intangibles

Given the same reliability, the cost of the machine will increase as either the capacity and/or the speed increases.

Before going into detail, however, there is one more compatability issue. In addition to being compatable with the software you plan to buy, also consider compatability with either software you currently have or would like to have, and other hardware used in the office and/or at home. Think about:

Media compatability - disk size; for example, it is difficult to fit a 5 1/4 inch disk in a 3 1/2 inch slot, or, an IBM PC AT can write to a double density disk, but a PC cannot read that disk.

Operating System Compatability - hardware must use the same operating system, and the same revision of that operating system.

Hardware Compatability - programs might require a graphics display or a special type of printer, etc.

Claims of compatability are not always what they seem; always test to make sure it works.

Now let's look at the hardware, itself.

A computer system is made up of different components. For each of these components, you must evaluate how much capacity and speed is needed for your software.

The five components are:

The CPU - Central Processing Unit
Memory
Storage Devices
Input Devices
Output Devices

CPU

The CPU is the part of the computer which does the work. It is where the arithmetic and logical operations are performed, and instructions are decoded and executed. What determines the capacity of the CPU is the design of the machine itself. When talking about capacity, you are talking about how much information the CPU can look at at once. The terminology used to describe the capacity of the CPU is 8 bits, 16 bits, 32 bits, etc.

Speed is also a consideration with the CPU. Measures of speed include clock speed and mips (millions of instructions per second). These both describe the functioning of the hardware, but the software design also affects the speed of the CPU.

MEMORY

Memory capacity is measured in bytes or characters of storage accessible by the CPU. Memory is the space within the computer where information is stored while being actively worked on. Memory is expandable on most machines up to an upper limit set by the CPU and operating system. You should purchase the maximum amount of memory used in your software application. This amount might be less than the maximum capacity of the machine. There is no advantage to having more memory than your software can use.

STORAGE DEVICES

Storage devices store large amounts of data on a magnetic media such as a disk or a tape. Storage devices cannot be read as quickly as data in the main memory, but the storage area is not erased when the machine is turned off.

Disks - floppies, hard disks and optical disks - are used to store and retrieve data. Tapes are used to archive data, for back up copies, or for information that needs to be saved but rarely used.

Storage capacity is how much information can be accessed, or, with a database, what size of database can be accessed. What sounds like a lot of storage capacity when you buy it is not all that much six months later. Computers are like flat surfaces, they collect stuff.

Storage capacity is measured in bytes or characters. A standard floppy disk holds 360 K. A 1.2 megabyte floppy can hold 1.2 million characters. Hard disks range in size from 10 megabytes to 100's of megabytes.

In a Database System, speed in data storage and retrieval is usually the overall limiting factor in the speed of the software application. A good demonstration of the software is imperative. The software cannot be effectively evaluated with a small sample database or with simple queries. How the data is organized will greatly affect the access time, regardless of the type of storage device.

What seems fast initially appears slower the longer you use any system. A response time of over 1 1/2 to 2 seconds actually slows down the user.

Hard disks are many times faster than floppies. However, all hard disks are not created equal; some are 100's of times faster than others. Remember, cost increases with speed.

INPUT DEVICES

The keyboard is the major input device in use today. The speed of input is limited by the person typing and the design of the software.

OUTPUT DEVICES

Terminals and printers are both output devices. Capacity and speed need not be considered when buying printers. Capacity on printers applies to the ability to do graphics, and how much, if any, data can be stored in the printer buffer.

The speed of printers is important. Speed is measured in characters, lines, or pages per second. Often there is a discrepancy between the manufacturer's rated speed and the actual speed, so a demo is again important.

Those are the five parts of the computer and the importance and effect of speed and capacity on each. Looking at the hardware specified by a software package can help you to evaluate that software. By knowing the limits of the capacity of the hardware, you can know the limits of the software. If you cannot get a full demonstration of the system, then get specific information on how long it takes to use each part of the software, given your parameters.