ABSTRACT

Computerized nutrient data base systems are available and can be utilized as instructional tools by dental, medical and other students in the allied health sciences in the study of nutritional science.

With these data banks, students can develop skills in the compilation and the analysis of patient food consumption histories, in the calculation of nutrient composition of foods, in the design and evaluation of individualized menus for meeting specific nutrient standards and objectives in preventive health care, and in the utilization of nutritional assessments for the development of clinical treatment strategies.

In the summer of 1982, such a data base system was designed and implemented by the academic computing services department (ACS) to support research, education and clinical applications in nutritional science at the Loyola University Medical Center (LUMC). With ACS programming and technical support, the nutrient data base system was designed as a very large SAS dataset residing on a large mainframe system available for general access by the academic and research communities at the medical center.

Very recently, in response to requests by the directors of preventive health care courses taught at the Loyola University School of Dentistry, an interactive system was quickly designed, tested and implemented by ACS which integrated the use of the nutrient data base system into the course curricula.

This system, a SAS application, consisted of two interactive components: BIOENTRY, a data entry subsystem, for the collection of food consumption histories and BIOQUERY, a DBMS access subsystem, for the retrieval and display of nutrient composition of selected foods contained within the data base.

The expanded DBMS features of the SAS/FSP product along with its interface abilities with various IBM mainframe subsystems, i.e., TSO, ACF2, AS/400 and JES2, were vital for the successful implementation of a computerized nutrient data base system for the teaching and study of nutritional science in the dental school undergraduate curriculum.

LOYOLA UNIVERSITY MEDICAL CENTER

Situated in west suburban Maywood, the Loyola University Medical Center consists of the school of medicine, a 515-bed teaching hospital, the school of dentistry, the school of graduate studies in the allied health basic sciences.

Since opening in 1969, this center, which adjoins a large VA hospital and a state mental health center, has become one of the more comprehensive health care complexes in the Chicago metropolitan area, and the only major health center serving the western suburbs.

ACADEMIC COMPUTING SERVICES

The medical, dental and nursing staffs are supported by a wide range of technical skills provided by ancillary support personnel. Facilitating access to computing resources for supporting education and research at the medical center is provided by the ACS department.

To accommodate the variety of academic computing needs which are particular to each campus, the academic computing services department maintains a computing center complete with technical staff on each campus. The services provided are dependent upon the campus environment, with the medical center being directed towards research.

The academic computing center, located in the dental school, is equipped with three IBM 3278 terminals, an IBM 3279 color terminal, an HP7221C flatbed plotter, remote job entry station, three AS/400 terminals, an optical mark reader device, three microcomputer systems, and access to IBM 6670 and XEROX 8700 laser printers.

UNIVERSITY COMPUTING RESOURCES

Mainframe computing resources are provided by an IBM 3033-U computer system with 16 megabytes of main computer storage and CPU processing capability at 5.0 MIPS. The mainframe system operates under MVS/SP 3.3.1 and supports both interactive and batch processing environments, with the assistance of the subsystems: ACF2, AS/400, JES2, ISPF/PDF, TSO and VAM.

Application software systems provide support for academic and administrative computing in such areas as (1) statistical computing: BMDP, MINITAB, OSIRIS, SAS and SPSS, and (2) research data base design and implementation: FOCUS, RAQL, SAS, SIR/DBMS and SIR/FORMS.

The IBM mainframe system also accommodates the administrative and academic computing needs for two other campuses located in Chicago -- one supporting undergraduate and graduate programs...
The contents of food composition tables have vitamins and mineral values were also listed. Nutrient data. Values for protein, fat, carbohydrate, and calories were included in the early food composition tables, and by 1945, vitamins and mineral values were also listed. The contents of food composition tables have been updated and expanded as laboratory procedures for analyzing nutrients have been improved. By the late 1950s, computer technology began to influence the distribution and utilization of nutrient data, i.e., development of computer-stored nutrient data bases.

Recent advances in microprocessor technology have created smaller nutrient data bases that are now available for use in the home at a reasonable cost -- benefiting from a new sensitivity and a growing awareness of the value of preventive health care by the American consumer through diet and exercise.

ACQUISITION OF THE NUTRIENT DATA BANK

Early in 1980, the department of preventive dentistry requested that ACS design and implement a computerized nutrient data base to support an on-going longitudinal study on the changes in the use of fructose in the American diet and its relationship with dental caries treatment. This was to be carried out using the food consumption histories, or diet diaries, compiled by participating families receiving dental treatment at various dental school clinics.

As a first step, the department recommended acquiring the computerized nutrient data bank developed by the diatetics department at Ohio State University Hospital. After an extended period of protracted negotiations, the nutrient data base was purchased by ACS in summer of 1982.

DESCRIPTION OF THE NUTRIENT DATA BANK

In its raw form the computerized nutrient data bank is a "flat file" consisting of over 6,800 records with each record comprising ten card-images. At least five megabytes of secondary storage is necessary to support the data bank.

The food item entries are keyed by a four-digit code assigned by the Ohio State University Hospital, OOH1 through OOH999. These numeric codes do not follow any structure. They are assigned in the order of entry into the data bank.

This massive collection of food items is classified into twenty-one major food groups, i.e., vegetables, fruits, dairy products and etc. Some of these food classifications are sub-divided further, e.g., vegetables are broken down into 38 sub-categories.

For every food item in the nutrient data base, there is a food description label, 60 characters in length, indicating the name of the food, the brand name (if appropriate), the cooking process and other identifying characteristics.

In the nutrient data bank, each food item is assigned: (1) a food classification code, (2) a sub-classification, (3) a household conversion code on how the food is portioned for individual serving, e.g., by ounce or cup, (4) the gram weight for the household serving portion and (5) date of the most recent revision of information for the food item.

In addition to the data on the quantity of kilocalories, the nutrient data bank provides composition data for 62 other possible nutrients, including protein, fats, carbohydrates, sugars, vitamins, minerals, amino acids and trace elements.

For each nutrient entry, there is (1) the quantity recorded which is based upon 100 grams of the particular food item, (2) the unit of measurement, e.g., mg or Hz, and (3) a code to indicate the source for the data on this particular nutrient, e.g., the U.S. Department of Agriculture.

CHALLENGES USING NUTRIENT DATA BANK

Given the space requirements for a computerized nutrient data base system, its rectangular design and its hierarchial structure, the first challenge for ACS was to design and implement a nutrient data base system to utilize the nutrient data. This involved converting the nutrient composition quantities from 100-gram units to household serving portion units.

The second challenge was to write and test data base access and retrieval protocols which allowed the nutritional science investigator access to the converted data base system with minimal programming effort.

SAS FACILITIES CREATE DATA BASE SYSTEM

For ACS, the SAS system seemed to be the most appropriate programming facility to use at the time, for three reasons: (1) its ability to handle a complexity of input formats, multiple-record observation, missing data and subsetting, (2) its data manipulation and transformation features and (3) its FORMAT utility useful in creating data dictionaries.

The "flat file" structure of the nutrient data bank was quickly converted to a large SAS dataset by ACS utilizing a hierarchial DBMS design using simple SAS programming facilities.

DIFFICULTIES WITH PROPOSED APPLICATION

The department was prepared to evaluate its...
extensive collection of diet diaries. However, several problems in program development arose at the onset:

1. How to design a data entry subsystem which was easy to use but would reflect the format of the diet diaries. Unfortunately, the manual diet diaries, as previously designed, did not provide for the inclusion of more specific information food preparation or brand names.

2. How to match the food items in the diet diaries with those in the nutrient data base -- without resorting to a manual search through the hard-copy listings of the nutrient data base.

3. This led to another consideration -- whether to use either an on-line search based upon pattern recognition of word phrases or a manual search through the hard-copy alphabetical listing of the nutrient data base which had been provided by Ohio State University Hospital.

4. Whether to use the SAS system interactively or in a batch environment.

Within a short time, the department's interests for this research application waned and the project was placed on one of many back burners. The medical center was now the proud owner of a computerized nutrient data base system searching for an application.

ANOTHER APPLICATION TO THE RESCUE

The department of preventive dentistry, in addition to carrying out epidemiological studies, presents courses on issues in preventive dentistry, public health and cariology, to the first-year students in the dental school curriculum.

Discussions between ACS and the department resulted in another proposal to design a system utilizing the nutrient data base by creating an interactive system that would provide for (1) the entry of diet diaries as compiled by students and (2) the calculation and summaries of nutrient composition of the foods recorded in the diet diaries for evaluation.

COURSE OBJECTIVES NEED SAS/FSP PRODUCT

The objectives for the preventive dentistry and cariology course for the student included: (1) to design, use and maintain an individual food consumption database, (2) to become more sensitive to one's own preventive health care needs, (3) to become familiar and more comfortable with using computerized data base systems through some "hands-on" experience and (4) to become more aware of computer technology and its applications in dental research, and clinical and practice management environments.

PROCESS FOR EVALUATING DIET DIARIES

The student was to compile a 24-hour diet diary, recording the food in a manner reflecting the nutrient data base. This was accomplished by using ordered hard-copy listings of the data base. For each food item recorded, the student determined (1) the major food classification, (2) its sub-classification, (3) the household portion unit, (4) quantities consumed based upon the household portion unit, (5) the food item four-digit code and (6) provided a personal description of the food item. This last item was of particular interest since not every food was included in the nutrient data base, and therefore testing the students' judgement.

After the data entry process was completed, the student would submit his diet diary for processing obtain a nutrient composition summary report of his 24-hour diet diary.

SOME OLD PROBLEMS AND A FEW NEW ONES

Since the compilation, entry and evaluation of diet diaries were to be counted toward the course grade, several new problems quickly arose for this proposed application:

1. There were about 140 first-year dental students enrolled in the course and very few have had any previous experience with computing.

2. The availability of disk space on the mainframe system may become a serious problem.

To counter these problems, the design of a successful interactive system had to insure that the data entry process would be straightforward, quick, error-free and relatively easy to use, hoping to keep the data entry process to one hour on the terminal.

While the problems presented in the earlier proposed application did not disappear with this proposed application, one distinct advantage did emerge -- the availability of nutrient data base codebooks to the first-year dental students before they would compile their diet diaries. The diet diaries could now be designed to reflect the structure of the nutrient data base system.

ANATOMY OF SAS/FSP APPLICATION

An interactive system was designed and implemented by ACS which comprised of two subsystems: a data entry subsystem, BIOENTRY, and a data retrieval and query subsystem, BIOQUERY.

Students were to use the BIOENTRY subsystem to enter their compiled diet diaries which were to be stored as computer files for processing and evaluation. The students would use the BIOQUERY subsystem to look up nutrient composition data on selected foods. In addition, several SAS job streams were set up
for processing the student’s diet diary, invoked by the BIOSTATS command.

BIOENTRY: Data Entry Subsystem

The BIOENTRY data entry subsystem was developed using the data entry features of the SAS/FSP product; the FSED/T procedure. Three Time-Sharing Option (TSO) command procedures (clists) were written to drive the subsystem:

1. BIOSETUP - enabled the student to secure disk space and allocate files used for diet diary entry, and created and initialized a SAS data set containing the data entry screen definition.

2. BIOENTRY - used by the student to enter his diet diary invoking the FSED/T procedure. This application consisted of one data entry screen for food consumption information from one meal. Therefore, if student had recorded five meals then he would invoke the screen template five times, creating five observations for his SAS data set.

The BIOENTRY clist also submitted a SAS job stream for batch processing. The SAS job printed out the data entered for the diet diary for verification by the student.

3. BIOSTATS - submitted another SAS job for batch processing which:
   a. Retrieved nutrient composition data from the data base for the food items recorded in the student’s computerized diet diary.
   b. Merged the retrieved data into the student’s diet diary.
   c. Transformed the SAS data set and calculate the quantities of nutrients, based upon weight of the quantity consumed, at various report-levels, for each food item, for each meal, for each day and for the duration of the project.
   d. Printed out the summary report using the report-generator features of the SAS system.
   e. Released any excess space from the student’s SAS data sets using the RELEASE procedure, thus freeing up disk space.

BIOQUERY: On-Line Query Subsystem

The BIOQUERY data base query subsystem used the retrieval and data display features of the SAS/FSP product, i.e., the FSBROWSE procedure. Two TSO clists were developed to drive the query subsystem:

1. BIOQUERY - to query the nutrient data base system for nutrient composition data on selected food items, using the editing commands of the SAS/FSP product in the BROWSE mode.

This application required a more intricate screen design, using four screens to display information for a particular food item. Judicious use of color was very useful to group nutrient composition data, e.g., amino acids or vitamins.

2. BIOMOUNT - submits a job for batch processing to "force" the allocation of the mountable disk pack containing the nutrient data base by invoking the IBM JEFBR1 system utility to effect the mount of the pack.

This clist would be used if allocation error messages appeared at the terminal, after invoking the BIOQUERY clist.

SAS FEATURES UTILIZED

This interactive system utilized several features of the SAS system for expedient design and successful implementation -- important criteria to determine the success of this interactive system which demanded simplicity and ease in use in very little time and which demanded that the nutrient composition data be displayed in a meaningful and useful manner.

The utilization of vital SAS system features included:

1. The FSED/T procedure for the dietary data entry subsystem.
2. Simple report routines, i.e., PROC PRINT, for listing the student’s diet diary.
3. File handling, data transformation and merge routines for extracting the nutrient composition data from the nutrient data base and incorporating it into the student's diet diary for statistical and report-generation processing.
4. File management routines, the RELEASE procedure, for releasing excess disk space from the student’s SAS datasets after the summary reports on nutrient composition were generated.

This procedure was an important discovery since available disk space was very critical for providing academic computing resources to other students relying upon the availability academic computing resources, particularly towards the end of the semester.

5. Descriptive statistical routines to summarized nutrient composition data at various levels, i.e., the SUMMARY procedure.
6. The FSBROWSE procedure for retrieval and the display of data.

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SAS procedures were also used to produced slides for class presentations on the nutrient data base.

INTERFACE WITH OTHER SYSTEMS

A very important feature of the SAS system, which insured the success of the BIOENTRY and the BIOQUERY subsystems, was its facility to interface with other systems on the mainframe.

Time-Sharing System (TSO):

The Time-Sharing Option (TSO) was necessary for driving the SAS/FSP product. TSO clists were critical for creating the subsystems that were very "user-friendly" at a minimal cost in development time. Given the number of students enrolled in the preventive health care courses, good and reliable TSO clists were necessary to accommodate those with little or no experience with computers and who did not have sufficient time to learn how to allocate files or submit jobs for background processing.

Automated Disk Management System (ASM2):

Data management tasks were handled by the Automated Disk Management System (ASM2), which is available from the Cambridge Systems Group. ASM2 is a menu-driven system consisting of various disk space management utilities: archive, backup and retrieval, which can be selectively invoked by the user.

Fortunately, there were students who elected to complete the course assignment earlier than others. Their diet diaries, which were SAS data sets, were then capable of being migrated (loaded) from disk to tape, making premium disk space available to their classmates.

Initially, only the students in the preventive dentistry course were to use the BIOENTRY and the BIOQUERY subsystems for 24-hour diet diary recalls. However, another course director requested to use the subsystems in the course on nutrition with the diet diaries covering a 72-hour period. Now, the interactive system (and the academic computing center) had to accommodate nearly 300 students in six weeks.

An unexpected benefit from interfacing with the ASM2 system was that it provided information in terms of work load. We were able to monitor on a weekly basis the number of students who would start on the interactive system, and note patterns of peak usage periods.

Access Control Facility System (ACF/2):

Data security was handled by the Access Control Facility system (ACF/2). ACF/2 protected the students' diet diaries from "read" and "write" access while the nutrient data base system was protected from any unauthorized "write" access. The systems software team supporting the IBM mainframe system was very gratified to learn that the SAS/FSP product lacked the ability to be used to undermine the ACF/2 system -- a question raised at an earlier BDUI conference.

STRAATEGIES IN USER EDUCATION

ACS made a 50-minute class presentation on how to use the interactive system -- both the BIOENTRY data entry subsystem and the BIOQUERY data base query subsystem. A slide presentation was developed and incorporated into the class presentation, using the GSLIDE procedure of the SAS/GRAPH product utilizing an IBM 3279 color terminal. Photographs for the slides were taken using a 35-mm camera and high-speed Ektachrome film. Color slides were also taken of the screens generated by the SAS/FSP product for both the BIOENTRY and BIOQUERY subsystems.

A user guide was written by ACS demonstrating how to use both the BIOENTRY and BIOQUERY subsystems -- step-by-step.

Documentation text was printed on the left side of the slide presentation. This was distributed to the students prior to their data entry in hopes they would be prepared before using the data entry subsystem.

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An unexpected benefit from using this writing style was that students were utilizing the user guides as laboratory workbooks because of the amount of screen display illustrations available in the documentation.

Codebooks and data dictionaries for the nutrient data base were generated using report-generation features of SAS with subsetting operands and laser printing hardware. This facilitated the student's compilation of his diet diaries, if he chose to look up the food codes manually. The food items with identification data were listed in alphabetical order within food classification subgroups for each food classification group. These codebooks were printed in limited quantities and maintained at public terminal areas and "on reserve" in the medical center library.

The most important user education task for ACS was keeping the student well-informed of any possible glitches in the interactive system, in terms of hardware difficulty, software "bugs", and logistical problems. Therefore, a user newsletter for the class was prepared and distributed giving updated information on the interactive system.

ANOTHER LOOK AT LOGISTICS

Keeping in mind that the academic computing center was supporting an interactive system for use by 300 students when only six to eight IBM 3270 terminals were available, a terminal reservation system with reasonable time limits was implemented.

Recently the University acquired the YALE 1UP system which permits certain ASCII terminal
types to emulate IBM 3270 terminals. Incorporating this new communications protocol system will expand the number of terminals available for using the interactive system -- and will permit the acquisition of additional low-cost ASCII terminals to expand the network.

A more difficult problem arose concerning the distribution of computer output which was generated by the batch processing from the BIOENTRY and BIOSTATS commands. The academic computing center at the medical center was not designed to accommodate 300 students expecting to obtain computer output.

The solution was found in using both the BIOENTRY and BIOSTATS lists to prompt for minimal JCL information and the student's mailbox number. Therefore, the computer output was generated displaying on the job header sheet the student's school mailbox number in large print. The computer output was then carried to the dental school mailroom for distribution.

ENHANCEMENTS FOR THE SAS/FSP PRODUCT

In the course of implementing this project, several problems were encountered which may be resolved with enhancements to the SAS/FSP product:

1. Handle multiple occurrence of variable groups for an observation without extensive SAS programming.

2. Jump across different SAS/FSP screen definitions based conditionally upon responses entered on previous screens.

3. Partition a SAS/FSP screen into windows enabling access to variables from more than one SAS data set, i.e., working with hierarchal or relational DBMS systems.

4. Design "help" screens, at the level of the variable, to be invoked by data entry personnel when needed.

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