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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