

# **Baseline Dietary Survey Methods for Ecologic Analyses in the Seven Countries Study (SCS). A 2021 Supplement.**

## **The Seven Countries Study Editorial Group†**

### **Introduction**

This report supplements earlier descriptions of the dietary survey methods for the baseline data collection among the 16 cohorts of the Seven Countries Study (SCS) (1-5). Diets of cohorts across a wide range of eating patterns were analysed for relationships of average nutrients consumed at entry (in per cent of energy) *versus* average serum cholesterol levels and subsequent cohort rates of death from coronary heart disease (CHD) and all-causes (1, 3, 4, 5). All analyses in these publications are confined to ecologic correlations of disease outcomes with dietary nutrients and other traits among the cohorts rather than among individuals within the cohorts. This strategy was taken from the outset by Ancel Keys and colleagues based on their extensive findings that dietary variation within individuals (intra-individual) was on the order of that among individuals (inter-individual). Thus, they considered it not practicable then--for field surveys of thousands of subjects--to measure individual diets sufficiently frequently or accurately to determine meaningful diet-disease relationships for individuals. That opinion is no longer uniformly held 50 years later, but it holds for this supplemental report on the baseline SCS dietary surveys.

### **Macronutrients**

The early SCS literature (1-5) addressed the prime question of that period: the relationships of disease and death rates across cultures to their average macronutrient consumption rather than to particular foods, food groups, or cultural eating patterns. The latter ecologic correlations became, however, the focus of later articles and popular books from the SCS (6-10).

### **Fatty acids**

In the 1960s, another intensely debated nutritional question was the amount and kind of fatty acids in the habitual diet of populations in relation to their average serum cholesterol level and CHD incidence or death rate (1). Information was lacking on dietary fatty acids intake among populations and about the validity of extant food composition tables to explore this question. Therefore, precise chemical analysis of average fatty acid composition of all SCS cohort diets was made centrally, at the University of Minnesota Laboratory of Physiological Hygiene, from whole-cohort composites of foods eaten by randomly chosen diet survey participants for each cohort (1).

### **Survey cohorts**

Baseline medical surveys were carried out in the field from 1958 through 1964 on all working men aged 40 through 59, living in 11 defined rural areas chosen for their apparently contrasting habitual diets; that is: the islands of Crete and Corfu of Greece; the rural provinces of Dalmatia and Slavonia in Croatia and the village of Velika Krsna in Serbia, all in the former Yugoslavia; the towns Montegiorgio and Crevalcore in Italy; rural provinces of Karelia and Turku of East and West Finland, and rural villages of Tanushimaru and Ushibuka in Kyushu Province, Japan.

Five other cohorts of men of the same ages, which were exceptions to the rural cultures compared, were added for the variety of their diets. These 5 were U.S. and Rome railroad workers, primarily studied for their within-cohort contrast in occupational physical activity; all men in the market town of Zutphen in the Netherlands for its intermediate geographic location between the northern and southern European SCS cohorts; and two other cohorts, one from the market town of Zrenjanin and another the entire male faculty of the University of Belgrade, added to explore the varied cultural comparisons possible in the former Yugoslavia.

### **Dietary data collection in the field**

Discrete dietary surveys--in randomly selected subsamples of men representing the regional cohort--were made in parallel with the medical surveys of risk characteristics and health. For 13 of the 16 SCS cohorts (minus the 2 railway studies and Ushibuka, Japan) each baseline dietary survey included: 1) 7-day food records of the kinds and

weights of all foods eaten by the cohort subsample during 7 successive days; 2) collection of a quantitative replicate of each meal; and 3) preparation of a 7-day composite of all meals consumed by the entire survey subsample for subsequent laboratory chemical analysis of macronutrients and fatty acids (1).

Teams of dietitians and local helpers carried out or supervised all food collections and measurements in each household of the dietary cohort subsample. Close contact was maintained by assigning a survey dietitian to each household for the actual collection and weighing of duplicates of the meals. Usually, to assure accurate records, one dietitian worked between only two neighboring households for the same survey.

In the U.S. railway occupational cohort (1957-1960 baseline survey), only one, 1-day food record was taken, and for the Rome rail cohort (1969) only one, 7-day food record. In the Ushibuka survey (1971), only one 4-day food record was recorded. Thus, no duplicate records were obtained for these 3 cohorts,.

In all 16 cohorts, estimates of food energy and macronutrient values for the edible parts of the foods consumed were computed from standard food tables available for each of the seven countries, plus information from special local food analyses (1, 2). Exceptionally, the composition of the average diet of the Rome railroad men (1969) and of the Ushibuka cohort (1971) was measured at their 10-year survey under the assumption its composition was similar to that at baseline. This was because their baseline medical surveys were conducted before the two cohorts were formally included in the SCS design.

The baseline SCS dietary survey subsamples ranged from 21 to 49 men per cohort (except for only 8 men in Ushibuka), for a total of 498 SCS participants, covering their food consumption during 3,282 days.

### **Tables for converting SCS baseline survey food records to macronutrient intake**

Food consumption tables were less advanced during the period of the SCS baseline dietary surveys than now (11). The following regional food tables were updated and utilized in the conversions from SCS baseline food consumption to cohort nutrient intake collected during baseline SCS surveys from 1958-1965 among 14 cohorts, from 1969 for

the Rome rail cohort and 1971 for Ushibuka; all data reported in the principal 5,10, and 15-year-follow-up SCS publications (1, 3, 4, 5).

### **Food tables and cohort references**

#### 1. United States of America

Watt BK, AL Merrill. Composition of foods—raw, processed, prepared.

U.S. Dept. Agric. Handbook No. 8. Washington, DC. 1963.

#### 2. Finland

Turpeinen O, P Roine. Food Composition Table (Ruoka-ainetaulukko) 4<sup>th</sup> edition. Helsinki 1964; 5<sup>th</sup> edition. 1965.

#### 3. Zutphen, the Netherlands

Nederlandse Voedingsmiddelentabel (Netherlands Food Composition Table)  
Voorlichtings-bureau voor de Voeding (Education Bureau for Food and Nutrition)  
The Hague. 1961 & 1962.

#### 4. Italy

National Institute of Nutrition, Rome. Composizione in principi nutritive e valore degli alimenti comunemente in Italia. Rome, 1968; and:  
Fidanza F, A Fidanza-Alberti. Valore calorica e composizione in principi nutritivi di alcuni alimenti italiani. Quad Nutr. 1963;23:117-126.

#### 5. Yugoslavia

Buzina R, A Keys, A Brodaric, and F Fidanza. Dietary studies in rural Yugoslavia. III. Comparisons of methods used. Voeding 1966;27(3):99-105.

#### 6. Greece

Keys A. Food composition. In: Dietary survey methods in studies on cardiovascular epidemiology. Voeding 1965;26:467-471.

#### 7. Japan

Standard Tables of Food Composition in Japan. Research Bureau. Science and Technology Agency, Tokyo, 1963.

### **Chemical analysis for macronutrients**

For the 13 cohorts having weighed foods, an aliquot (1/10th by weight of all food and drink consumed by each randomly selected participant during the survey week) was collected and combined into a composite representing the entire cohort. These aliquots were stored in low-temperature refrigerators and lyophilized samples sealed in small glass containers and shipped to the Minnesota Laboratory of Physiological Hygiene for chemical analysis (for the cohorts of Dalmatia, Slavonia and Tanushimaru), and to local academic laboratories standardized with the Minnesota laboratory (for the cohorts in Finland, the Netherlands, Italy, Greece and Serbia). There, samples were analyzed chemically for water, ash, total protein, and total fat, with the residual reported as the estimate for carbohydrate. The frozen composite food samples from all 13 cohorts were later chemically analyzed for saturated, monounsaturated, and polyunsaturated fatty acid content in only one central laboratory, at the University of Minnesota (1).

### **The special case of the Greek Islands baseline dietary surveys and chemical analysis**

Additional seasonal surveys of food consumed on Crete and Corfu were carried out because their baseline diet surveys were made in February in Crete and March-April in Corfu, the latter during the 40-day Lenten fasting period of the Greek Orthodox Church. Subsequent dietary surveys in both cohorts indicated that strict adherence to fasting was not common. Three dietary surveys on Crete and 2 on Corfu made both 7-day consumption records and chemical analysis of foods (1, 12). Average energy intake on Crete was 2769 kcal/day in September 1960, 2848 kcal/day in May-June 1962, and 2626 kcal/day in February 1965, and on Corfu was 2796 kcal/day in September 1961 and 2877 kcal/day in March-April 1963. In all 5 dietary surveys the calculated value from food tables was higher, but not significantly so, than per cent nutrient energy chemically measured (12).

These systematic and repeat surveys of the same Greek cohort subsamples--with food table conversion and chemical analyses by the same teams and laboratories--effectively

confirmed the overall SCS decision to deal with ecologic relationships of the diet of the cohorts versus other characteristics and disease risk, rather than correlations with the diet of individuals: “Repeated surveys on the same men showed intra-individual variability to be a large part of the total variability in regard to total calories, alcohol calories, and percentages of calories from proteins and from fats. The individual values from a single survey are of very limited use in predicting individual values in a second survey” (12, pg. 68).

### **Average cohort nutrient values. Food table conversions *versus* chemical analysis**

To compare baseline chemical analysis data on nutrients to their estimates based on food tables, local foods were purchased in each area during the early 1960s, intended to match those foods of the original 7-day baseline food records (1). The quantities resulting from chemical analyses of the 13-cohort equivalent food composites were similar to those from food table estimates for average total energy, protein, fat, carbohydrate, and fatty acids.

This general finding was documented in a special 1960’s nutrition study of the diet history--the one-week record and the one-week sampling and chemical analysis method--among the entire Zutphen cohort (13). It found a small systematic difference between the direct and estimated measurements for all 852 men of the cohort: average percentage of total energy estimates was 12.1 for total protein and 43.1 for total fat from the cross-check dietary history using food tables and was 12.1 for total protein and 42.0 for total fat by chemistry. Several other smaller random samples drawn from the Zutphen cohort using diet histories varied closely around 12 per cent for total protein and from 41-43 for total fat.

This detailed comparison within the entire Zutphen cohort also allowed estimates of the baseline diet composition for the U.S. rail cohort in 1960-62 and the Rome railmen and Ushibuka cohorts by using their 10-year follow-up diet survey data, since neither dietary records nor food collections were collected at their actual baseline surveys.

### **Cohort differences in foods rather than nutrients consumed**

In the early SCS baseline reports interest was focused on regional differences in the proportion of calories from macronutrients and fatty acid classes, along with their relation

to other physical characteristics and to future risk of CHD (1, 3, 4, 5). Subsequent SCS reports also dealt with differences in foods consumed and eating patterns and their disease correlates (6, 7, 8, 9, 10). These relationships were analyzed by characterizing baseline food consumption data for 13 of the 16 cohorts as the edible part of the raw products and in the 3 other cohorts as prepared products. For example, in the Roman and U.S. railroad men and the Zutphen diet cohorts the prepared foods were recorded as: meat, fish, vegetables, cereal products, and legumes. To compare these 3 with the 13 other cohorts, the quantities of prepared products were converted in a standardized way into quantities of raw products--by the SCS investigators in cooperation with local dietitians and nutritionists--into 14 food groups of similar water content and nutrient composition: bread, cereals, potatoes, legumes, vegetables, fruit, meat, fish, eggs, cheese, milk, edible fats, sugar products and pastries. The average consumption of these food groups for the entire dietary subsample of a cohort was calculated from the individual data. The important ecologic correlations of food group data with blood lipid levels and disease rates among the SCS cohorts (6, 7, 8, 9, 10) are beyond the focus of this supplement to the survey methods for the baseline publications (1-5).

† **Daan Kromhout and Alessandro Menotti, co-chairmen; David Jacobs, and Henry Blackburn, members. 2021.**

## References

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2. Keys A, Kimura N. Diets of middle-aged farmers in Japan. *Am J Clin Nutr* 1970;23:212-223.
3. Keys A (Ed.) *Coronary heart disease in seven countries. XVII. The Diet.* *Circulation* 1970;41, Suppl 1:162-183.
4. Keys A *Seven Countries: A Multivariate Analysis of Death and Coronary Heart Disease*. Cambridge, MA: Harvard University 1980.
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12. Keys A, Aravanis C, Sdrin H. The diets of middle-aged men in two rural areas of Greece. *Voeding* 1966;27:575-586. (<http://edepot.wur.nl/380320>)



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\*Individual references to *Voeding* volumes containing methods for each regional SCS dietary survey are as follows:

Italy: *Voeding* 1964;25:502-509.

Finland: *Voeding* 1964;25:383-393. *Voeding* 1967;28:470; & *Voeding* 1967;28:1-8.

Zutphen whole-cohort repeat surveys: *Voeding* 1965;26:184-208.

Dalmatia and Slavonia: *Voeding* 1966;27: 31-36.

Greece: *Voeding* 1966;27:575-586.