

FAT IN THE DIETS OF YOUNG WOMEN

by

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B.S., Southwest Texas State University, 1973

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Foods and Nutrition

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1976

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INTRODUCTION

One of the major health problems in the United States today is atherosclerosis, which often leads to coronary heart disease (CHD). Although atherosclerosis affects elderly persons most often, there is an increasing incidence of its occurrence in younger populations (1). The major emphasis in the study of CHD has been on men. However, CHD kills more women, as well as men, at all ages than any other factor (2).

Recommendations for dietary changes to combat atherosclerosis have been made by the American Heart Association (AHA) (3), the Food and Nutrition Board of the National Academy of Science (4), and the Council on Foods and Nutrition of the American Medical Association (5). Specific suggestions include: a) caloric intake should be balanced for maintenance of optimum weight, b) dietary cholesterol should be reduced to less than 300 mg/day, c) calories from fat should not exceed 35%, and d) saturated fatty acids should supply no more than 10% of total calories and polyunsaturated fatty acids (PUFA) should supply at least 10% of total calories.

In spite of the recommendation for decreased dietary fat, food fat available/person/day in the United States continues to rise (6). However, saturated fatty acids are accounting for a smaller share and linoleic acid for a larger share of total fat available. The 1965-66 United States Department of Agriculture (USDA) Household Food Consumption Survey reported the proportion of calories from fat in the food eaten by individuals to be above the 35% level thought to be desirable (7).

The objectives of this study were to: a) determine amounts and food sources of dietary fat, b) estimate distribution of calories among fat, protein, and carbohydrate, and c) determine P/S ratio (polyunsaturated to saturated fat) in the diets of a group of young women.

REVIEW OF LITERATURE

Dietary Study Methods

There is no generally accepted method of measuring the dietary intake of free-living individuals. The literature on dietary survey methodology is vast (8). Mann et al. (9) stated, "a superficial examination of the technical problems experienced in measuring dietary intake meets such a morass of conflicting opinions that the first inclination is apt to be a decision for abandonment." Comparisons of dietary survey methods have been made, but they were comparisons between methods whose accuracy and reliability are not known (10).

Commonly used methods of dietary survey include: a) the dietary history and its variations, b) the 24-hour recall, and c) the dietary record. In estimating food intake of individuals, results among methods vary with the population group studied and with specific foods and nutrients; there is no consistent pattern of variation (11-13). Therefore, it is impossible to predict with any accuracy, results that would be obtained by one method by projecting values obtained by another method. There is no proof that one method is more reliable than any other (10). Young et al. (11) found that the 24-hour recall and 7-day record could be used interchangeably to obtain a group mean. The method chosen should depend on the objectives of the study. Only one method should be used within a particular study (10).

The Dietary History

The dietary history attempts to determine average dietary intake over a considerable time period through the use of an extensive interview.

Information is obtained in regard to the subject's health habits and other factors that relate to nutrition. The interviewer attempts to learn the subject's usual eating pattern and tries to integrate weekly and seasonal variation. Information obtained by this method often is compared with clinical and laboratory findings. Taking dietary histories is time-consuming and it assumes that the subject has well-established food habits (9, 14).

The 24-Hour Recall

This method consists of a brief interview in which the subject is asked to recall all food intake over the past 24 hours, starting with the last meal or other food intake. The 24-hour recall provides for savings in time of collection, calculation, and analysis of data. Since it requires little of the participant's time and cooperation, a more representative sample may be possible (11).

The Dietary Record

The dietary record is a common survey tool that can be used in any area where people are literate (15). The food may be weighed, measured, or estimated and reported in household measurements. Estimating amounts of food consumed has certain advantages: a) it is less demanding than weighing or measuring, b) a high degree of cooperation is possible, and c) no special equipment is necessary (8).

The record must be as complete as possible. Failure to enter information or to describe the details of the measurements makes the record less valuable (8). The subject's recording of food intake introduces error depending on his ability to estimate, his degree of interest, and the care

he takes. Error in estimating portion sizes is the largest source of error (16). Young et al. (16) compared calculated nutritive value of "actual" or measured food intake with that of the subject's estimation of intake on both a group and an individual basis. On a group basis, when food intake was converted to calculated nutritive values, the subject's errors in estimation of food portions seemed to contribute relatively little as a source of error. In studying the nutrient intake of an individual, the subject's ability to estimate food portions could become a large source of error.

In planning to use the dietary record as a survey method, one must decide on the time period to be covered. Chalmers et al. (17) stated that the time period should be long enough for adequacy, but not so long as to lose the subject's interest and cooperation. When characterizing the dietary intake of a group, one day is sufficient. To obtain greater precision, it is more efficient to use more subjects than to take more days. The number of days needed to characterize the dietary intake of an individual depends on the precision required and differs with every individual.

As to which days should be used, Chalmers et al. (17) found no differences among days for some groups and certain trends in daily intake for other groups. For example, college students' food intake decreased on weekends. Eppright et al. (18) found that weekend eating habits of school children from 3 states in the North Central Region differed significantly from weekday habits. Chalmers et al. (17) concluded that there is no consistent "day effect"; thus, it is immaterial which days are selected for a dietary record as long as no distinct tendency for a specified population is observed. The absence of a day effect might be expected, but should not be

assumed without investigation. In determining food intake of individuals, the presence or absence of a day effect depends on the individual.

The adequacy of a 7-day survey in assessing an individual's average dietary intake is questioned. Adelson (19) compared the results of dietary records kept by a group of business and professional men in Minneapolis-St. Paul for two consecutive weeks, and concluded that one week proved satisfactory for obtaining a group picture of dietary intake. However, when attempting to assess an individual's average intake, workers found considerable weekly variation in calorie and nutrient intake (20-22). The degree of variation differed with dietary component and subject (21, 22). Huenemann (20) concluded that no single dietary record is "typical" of food intake of an individual over a period of time. Records should be repeated several times during the year rather than for several consecutive weeks to give a sufficiently accurate assessment of average intake by an individual (20, 21).

Tables of Food Composition

Nutritive values of diets are obtained by chemical analyses of the foods or calculated from tables of food composition. Murphy et al. (23) discussed the availability, uses, and limitations of tables of food composition. Data in Handbook No. 8 (24) and Home and Garden Bulletin No. 72 (25) are representative values based on a) review of information from previous publications, b) examination of new information available from unpublished material and from the literature, and c) derivation of values that are most nearly representative of a food for year-round nationwide use (23). Data

in tables can be considered representative of foods as marketed or consumed. Nutrient losses during processing are accounted for (23).

Data presented in food tables are not precise enough for use in metabolic studies. Food tables are useful in a number of ways, including assessing the nutritive value of diets over a period of time, conducting surveys of household food consumption, and assessing an individual's food intake for a brief period to serve as an index to the nutritive value of his diet for an extended time (23).

Some discrepancies between values obtained by calculation from food tables and those obtained by chemical analyses are expected, because of limitations of food tables (26). The more common or usual the foods in the diet, and the more simply they are prepared, the more representative will be the values calculated for them. Ingredients of mixed dishes made commercially or in restaurants are often sources of error (27). Stock and Wheeler (28) found that items such as fried foods, soups, and sauces, which have high and variable fat content, made major contributions to differences in calculated and analyzed values of fat intake. Fried foods presented a particularly difficult problem because the fat content depended largely on cooking procedure. The range of differences between calculated and analyzed values was smaller for individuals who chose "simple" diets with few foods and used few multi-ingredient and fried foods. Stock and Wheeler (28) concluded that considerable variation in fat content, and hence, energy content of many cooked foods, has to be accepted as inherent in dietary surveys. They estimated that in a 7-day survey, calculated protein and energy intakes will fall within $\pm 20\%$ of the analytical value in 90% of individuals.

Groover et al. (29) compared calculations of total calories and calories from fat in various diets, individual diet samples, and individual food items with actual number of calories, as measured by the bomb calorimeter. The majority of calculated values were higher than the analyzed values, the largest error being made in calculating calories from fat. More recently, Marshall et al. (30) analyzed meals used in a metabolic study and compared the results to protein, carbohydrate, fat, and cholesterol values calculated using Agriculture Handbook No. 8 (24); analyzed and calculated values were exceptionally close.

Dietary Fat and Health

Dietary Fat and Atherosclerosis

Epidemiological studies provide evidence that dietary fat, among other factors, plays a definite role in the etiology of CHD (31). When each of the major risk factors is weighted according to its contribution to atherosclerotic disease complication, serum cholesterol is one of the most important (32). The influence of food patterns and eating habits on serum cholesterol level and the prevalence of atherosclerosis has been demonstrated by studies of many population groups. Keys (33) studied CHD in middle-aged men living in 7 countries, and concluded that 80% of the serum cholesterol variability among those groups could be explained by the different proportions of saturated fat in the diets. Scrimshaw and Guzman (34), upon examination of epidemiological data, found significant correlations between atherosclerosis and percentage of calories derived from fat, atherosclerosis and serum cholesterol levels, and percentage of calories derived from fat and serum cholesterol levels.

Information about coronary atherosclerosis in young women is limited. Engel et al. (35) found a family history of myocardial infarction, hypertension, or diabetes present in 95% of the atherosclerotic young women they studied. Eighty-six percent of the women had 3 of the following 5 risk factors: family history of myocardial infarction, hypertension, or diabetes; hypertension; hyperlipidemia; glucose intolerance; and cigarette smoking. Oliver (36) studied 145 young women with ischemic heart disease and found hypercholesterolemia to be the most common risk factor; it was present in 46% of the women.

Biological Effects of Polyunsaturated Fatty Acids

Cholesterol-lowering effects. The influence of PUFA on cholesterol metabolism has been explored widely. It is established that PUFA have a lowering effect on serum cholesterol. However, there are conflicting reports as to whether there is a reduction of cholesterol or merely a redistribution of cholesterol between the plasma and the tissues. Connor et al. (37) accounted for serum cholesterol reduction in enhanced fecal steroid excretion. However, in other studies (38, 39), the fall in serum cholesterol could not be accounted for in fecal losses of cholesterol and its metabolic products.

Effects of hydrogenation. Commercially, oils high in PUFA undergo partial hydrogenation to stabilize against autoxidation. The PUFA are converted to the more stable monoenoic and saturated fatty acids through addition of hydrogen at the double bonds. Many of the double bonds are isomerized and the naturally occurring cis-fatty acids are converted to the trans form. The trans-fatty acid content of hydrogenated products varies.

Kummerow (40) reported that stick margarine contains from 25-35%, tub margarine 15-25%, shortenings 20-30% and salad oils 0-15% trans-fatty acids. He estimated the total trans-fatty acid intake from visible fat in the American diet to be approximately 8%.

Though hydrogenation and production of trans-fatty acids are considered desirable from a technological point of view, the nutritional implications are being questioned. Biologically, trans-fatty acids are reported to function differently from cis isomers (41). The difference in spatial configuration between cis and trans isomers reportedly causes trans unsaturated fatty acids to be less effective in lowering blood lipids than cis isomers (42). When human subjects were fed a hydrogenated fat (as 40% of total calories) which contained 35% trans-fatty acids, serum cholesterol levels were increased (43). However, Mattson et al. (44) found no change in plasma cholesterol or triglyceride levels over a 4-week period in men fed a diet high in trans-fatty acids. Much more study is needed before conclusions can be drawn as to the effects of trans-fatty acids in the diet.

Potential adverse effects. There have been reports of potential adverse effects of consuming a diet excessively high in PUFA. Those effects include premature aging, tissue damage, increased vitamin E requirement, and carcinogenesis (45, 46). Pearce and Dayton (47) noted an increased incidence of cancer and mortality in persons who were following diets containing 16% of calories as PUFA. However, no statistical association was found and work by other researchers does not support those findings (48).

Michael et al. (49) found that heating oils with a high PUFA content produced toxic and potentially carcinogenic substances. Feeding oils that have undergone prolonged heating caused severe ill effects in laboratory

animals (50, 51). Sugai et al. (52) demonstrated that laboratory-heated oil may act as a co-carcinogen. However, Nolen (53) observed that commercially-used frying fat had minute amounts of toxic substances and produced no appreciable ill effects on laboratory animals.

Use of Food Fats and Oils in the United States

Fat in the Food Supply

National food supply statistics (54) on the U.S. diet since the beginning of this century show how changes in food consumption have resulted in changes in level and sources of dietary fat. To estimate the fat content of the U.S. diet, appropriate food composition values are applied to quantities of food available/person based on amounts of food that disappear into civilian channels. Those amounts represent food used up in an economic sense. Although not a measure of fat actually ingested, such estimates are useful for showing trends in overall patterns of consumption (6).

On examination of food supply statistics, several trends become evident. Food fat in the U.S. food supply has increased approximately 1/4 over the past 6-1/2 decades on a per person/day basis. This large increase primarily is attributed to use of more vegetable fats. There have been large decreases in consumption of butter and lard, but that has been offset partly by increases in fat associated with greater consumption of meats; thus, animal fats continue to provide the largest share of the calories provided by fat (6, 54).

From 1909-13 to 1972, the proportion of calories derived from fat in the American diet rose from 32 to 42%, but calories from protein remained the same, 12% (6, 54). Although the American diet contains more fat than it

did 60 years ago, total saturated fatty acids now account for a smaller share of the total fat, 36% today as compared with 40% in 1909-13.

Saturated fatty acids account for 15% of total calories in the diet, up from 13 to 17%, and for linoleic acid, up from 3 to 6% (6, 54).

Projections for 1985 indicate that the present trends in the use of food fat in the U.S. will continue (55). The use of table spreads (butter and margarine) is projected to remain steady, with margarine continuing to displace butter. Cooking fats are projected to increase about 2 pounds per capita, with gains in shortening more than offsetting the lard downtrend. Cooking and salad oils will continue to lead the increase in consumption of food fat products with a potential of 5 pounds by 1985.

Fat in the Diets of Individuals

Average daily intake of fat by men, women, and children of various ages was determined in the 1965-66 USDA nationwide survey of diets of individuals by means of 24-hour recall (7). The level of fat in the diets paralleled the amount of food eaten, measured in calories. No consistent differences in fat intake were noted for persons living in urban and rural areas. With few exceptions, the level of fat increased with increased income. Contributions of fat to total calories in the diets ranged from 39% for infants to 45% for men 20-64 years of age, with women 20-34 years old deriving 43% of calories from fat (6, 7).

METHODS

The survey sample consisted of 60 young women randomly selected from approximately 430 females with American cultural background who were residing in Jardine Terrace, the married student apartment complex at Kansas State University. The instrument consisted of: a) background information and b) instructions and forms for completing a 7-day dietary record. Copies of the various forms are in the Appendix. The survey was conducted by one interviewer between February 15 and April 15, 1976. The interviewer contacted each woman personally and presented her a letter of introduction. The purpose of the study and requirements of participants were explained briefly and the woman's cooperation was requested. If she agreed to participate, she was asked to sign an agreement and release form.

Background information obtained included: date of birth, citizenship, height, weight, occupation, and number in household. When a woman was on a special diet or did not have an American cultural background, an alternate subject was selected.

Instructions and forms were given for keeping the 7-day dietary record. The interviewer explained the procedure and pointed out frequently-made errors. The subject was asked to contact the interviewer if she encountered any problems in completing the record. The records usually were picked up daily at which time incomplete or unclear information was clarified.

Dietary intakes of calories, protein, total fat, saturated fat, oleic acid, and linoleic acid were calculated for each subject from food composition data in Home and Garden Bulletin No. 72 (25). Because of sampling variation, it was not considered meaningful to use simple means for

estimates of population parameters. Therefore, ninety percent confidence intervals were used to estimate daily nutrient intakes for the entire population of women living in Jardine Terrace. Ninety percent confidence intervals also were calculated to estimate the P/S ratio for the entire population.

The factors of 4, 9, 4 for protein, fat and carbohydrate were used to estimate the number of calories derived from those nutrients in the diets of each subject. Then ninety percent confidence intervals were calculated to estimate the percentage of calories derived from fat, protein, and carbohydrate for the entire population of young women.

The percentage of dietary fat derived from seven major food groups was calculated for each subject and ninety percent confidence intervals were used to estimate those percentages for the entire population. The major food groups included: milk and milk products; meat, poultry, and fish; other protein foods (eggs, legumes and nuts); vegetables and fruits; grain products; fats and oils; and sugars and sweets. The "fats and oils" group was divided further into butter, margarine, lard, vegetable fat, salad oil, salad dressing, and imitation cream products.

RESULTS AND DISCUSSION

Sample Characteristics

Sixty young women completed 7-day dietary records. Their ages ranged from 18 to 35 years with a mean of 22.3 years. Height ranged from 60 to 74 inches (152 to 187 cm) and weight from 95 to 190 pounds (43 to 86 kg) with means of 65.2 inches (166 cm) and 132.6 pounds (60 kg). Thus, average weight for the group was within the range of suggested weights for height of women (56). However, 28% of the sample women were overweight and 12% were underweight compared to their suggested weight for height. Though none of the women was on a special diet, many commented that they were "trying to cut down" on food consumption.

As to household composition, 45 women were living with their husbands, 10 with their husbands and 1 child, 3 with a child only, and 2 women were living alone. Twenty-eight of the group were students, 24 were working outside the home and 8 were neither students nor employed outside the home.

Nutrient Intake

Estimated daily intakes of food energy, protein, fat, saturated fatty acids, oleic and linoleic acids, and carbohydrate for the population are presented in table 1. Ninety percent confidence intervals were used to allow for reasonable sampling error. For example, it is estimated that the true average food energy intake for the population sampled is between 1507 and 1761 kcal. Unless an unusual (1 in 10) sample was obtained, that interval is correct. Caloric intake fell below the recommended dietary

allowance (NRC-RDA) (4) for this age group whereas protein intake exceeded the NRC-RDA. The caloric intake observed in this study is in fairly close agreement with that reported for 20- to 34-year-old women in the \$3000-\$4999 income range in the 1965 USDA survey (7). The First Health and Nutrition Examination Survey (HANES) (57) indicated that 18- to 44-year-old women living above the poverty level had a mean caloric intake of 1,680, which fell within the interval estimated in the present study. Protein intake was slightly lower than that observed in the two studies cited above. Fat intake was lower, but carbohydrate intake was in line with the 1965 USDA data (7). Values for total calories, fat, protein, and carbohydrate were all lower than those reported by O'Leary and Lee (58) for single university women living at home. However, whereas their sample was chosen to exclude students who prepared their own meals, all but 8 of the women in the present study were students or working wives who were responsible for preparing meals for themselves and their families.

TABLE 1

Estimated daily nutrient intakes for a population of young women

Nutrient	Confidence interval ¹
Food energy (kcal)	1507 - 1761
Protein (g)	59 - 66
Carbohydrate (g)	174 - 212
Fat (g)	64 - 75
Saturated fatty acids (g)	21 - 25
Oleic acid (g)	23 - 27
Linoleic acid (g)	10 - 13

¹ Ninety percent

It is recommended that calories derived from fat not exceed 35% of total calories (3-5), but 37 to 40% of the calories consumed by this population were derived from fat (table 2). However, calorie intake from fat for the group was lower than the mean (43%) observed for young women in the \$3000-4999 income level in the USDA 1965 survey (7) and similar (38-40%) to that reported by O'Leary and Lee (58). Percentage of calories derived from protein was the same as in the two studies cited above. Carbohydrate contributed more calories to these diets than observed in the USDA survey (40%), but was similar (44-46%) to the contribution observed by O'Leary and Lee (58).

TABLE 2

Estimated percentage of calories derived from fat, protein, and carbohydrate for a population of young women

Source	Confidence interval ¹
Fat	37 - 40
Protein	15 - 17
Carbohydrate	45 - 48

¹Ninety percent.

The percentage distribution of calories derived from fat, protein, and carbohydrate for the 60 women in the sample is shown in table 3. There is wide variation (20 to 60%) in the percent of calories derived from fat, but 40% of the women derived 35-40% of their calories from fat. Protein supplied 15-20% of total calories for 53% of the subjects. Carbohydrate supplied 40-55% of total calories for 75% of the sample.

TABLE 3

Percentage distribution of 60 young women by calories from fat, protein, and carbohydrate

	Percent of total calories										
Source	9.9-15	15.1-20	20.1-25	25.1-30	30.1-35	35.1-40	40.1-45	45.1-50	50.1-55	55.1-60	
Fat	-	-	1.7	-	23.3	40.0	26.7	5.0	1.7	1.7	
Protein	36.7	53.3	6.7	3.3	-	-	-	-	-	-	
CHO	-	1.7	-	-	3.3	8.3	26.7	25.0	25.0	10.0	

It has been recommended that the P/S ratio in the diet be 1.0 (3-5). However, only 6.7% of the subjects had a P/S ratio above 0.80 (table 4). The mean for the population is estimated, with 90% confidence, to lie between 0.46 and 0.54.

TABLE 4
Percentage distribution of 60 young women by P/S¹ ratio

P/S	0.00-0.20	0.21-0.40	0.41-0.60	0.61-0.80	0.81-1.00	1.01-1.20
%	3.3	30.0	33.3	26.7	5.0	1.7

¹Polyunsaturated to saturated fatty acids.

Sources of Dietary Fat

The major food groups that supplied fat in the diet were meat, poultry, and fish; grain products; fats and oils; and milk and milk products (table 5). More fat came from milk and milk products, grain products, sugars and sweets, and fat and oils than was reported for 20- to 34-year-old women in the 1965 USDA survey (7). The USDA survey reported 42.3% of dietary fat derived from the meat, poultry, and fish group, whereas in the present study it was estimated that only 22-26% of dietary fat was derived from meat, fish, and poultry.

Approximately 1/2 of the fat contributed by the fats and oils group was derived from margarine and almost 1/3 from salad dressing (table 6). Vegetable fat and salad oil combined contributed approximately 1/10 of the fat from this group. The contributions of butter and lard were small, as was that of imitation cream products. The fats and oils group may

TABLE 5

Percentage of dietary fat derived from various food groups
for a population of young women

Food group	Confidence interval ¹
Milk and milk products	16 - 20
Meat, poultry, and fish	22 - 26
Other protein foods (eggs, legumes, and nuts)	5 - 7
Vegetables and fruits	8 - 11
Grain products	18 - 22
Fats and oils	16 - 25
Sugar and sweets	1 - 2

¹Ninety percent.

TABLE 6

Percentage of fats and oils derived from various food sources
for a population of young women

Source	Confidence interval ¹
Butter	4.5 - 8.7
Margarine	46.1 - 55.0
Lard	1.0 - 3.3
Vegetable fat	1.5 - 4.4
Salad oil	6.5 - 8.0
Salad dressing	28.1 - 31.0
Imitation cream products	0.6 - 1.3

¹Ninety percent.