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# FATS IN FOOD AND DIET

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This publication has been prepared for use in answering nonmedical questions about the effects of dietary fat on health.

The public has many questions about the relation of the kind and amount of fat in the diet to health and to the development of atherosclerosis. Atherosclerosis, a type of arteriosclerosis, is a disease of large and medium-size arteries characterized by deposits of fatty material along the internal arterial wall which narrow the passage-way. Atherosclerosis is responsible for most coronary heart disease and also plays a major role in cerebral thrombosis (stroke).

Most of the questions asked by consumers relate to (1) the importance of fat and other foods in the development of atherosclerosis, (2) polyunsaturated fats, and (3) the linoleic acid and cholesterol content of foods.

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# FATS IN FOOD AND DIET

Prepared under the direction of Ruth M. Leverton,<sup>1</sup> Agricultural Research Service

Diet is only one of many factors associated with the development of atherosclerosis and increased risk of coronary heart disease. Other factors include heredity, obesity, high blood pressure, high blood cholesterol and high blood lipids, cigarette smoking, lack of exercise, stress, and certain metabolic diseases such as diabetes.

Scientific opinion varies as to the specific role played by different foods and nutrients, especially fats, in increasing or decreasing the risk of atherosclerosis.

There is consensus, however, about the importance to health at every age of—

- A balanced diet suitable for one's age and activity.
- Maintaining desirable weight.
- Moderation in the total amount of fat in the diet.
- Variety in the kinds of fat or fatty acids in the diet.

These factors and the cholesterol content of foods are discussed on the following pages.

## A BALANCED DIET

A balanced diet is one that includes the kinds and amounts of food which will provide the needed quantities of essential nutrients and energy. Amounts of protein, calories, vitamins, and minerals needed

by different sex-age groups for nutritional well-being are recommended by the Food and Nutrition Board of the National Academy of Sciences-National Research Council and referred to as Recommended Dietary Allowances (RDA's).

USDA nutritionists have trans-

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<sup>1</sup> Retired.

lated these nutrient recommendations into food recommendations in "Food for Fitness—A Daily Food Guide" (Leaflet 424).<sup>2</sup> In the Guide, foods are grouped according to their nutrient content into the Vegetable-Fruit Group, Milk Group, Meat Group, and Bread-Cereal Group. The Guide recommends the minimum daily number of servings from each group needed

to provide a substantial proportion of the RDA's.

Other foods or additional servings selected from the four food groups, or both, are expected to supply additional amounts of the nutrients and meet energy needs. The Guide permits as wide a choice as possible within each food group and allows free choice in selecting additional foods.

### LIMITATION IN TOTAL CALORIES

This means seeing that the total caloric intake from food (and alcohol) does not exceed a person's energy need. Calories in excess of those needed for energy expenditure are stored in the body as fat.

Lack of exercise is one of the chief causes of overweight and, for most sedentary people, suitable ex-

ercise is one of the best means of weight control.

USDA has two publications to help consumers with weight control: Home and Garden Bulletin 74, "Food and Your Weight"<sup>1</sup> and Agriculture Information Bulletin 364, "Calories and Weight—the USDA Pocket Guide."<sup>3</sup>

### MODERATION IN TOTAL FAT

There is no specific definition of moderation, but for most of us it means using less fat than we are in the habit of using. This applies especially to the fat we add to food during preparation and at the table. It is not unusual for fat to supply 45 to 50 percent of the total calories in an American diet. In a nationwide survey, fat supplied an average of 45 percent of the total calories in the diets of young and middle-aged men.

Some advocates of moderation be-

lieve that 38 to 40 percent of the total calories from fat is a reasonable goal. In most diets this reduction can be achieved by simply cutting down on the amount of visible or separable fat used.

Some advocates have a stricter definition of moderation and say that less than 35 percent of the total calories should be supplied by fat. This much reduction in fat intake is not difficult to achieve but requires some modification in food choices and methods of preparing food.

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<sup>2</sup> Single copies available from Office of Communication, U.S. Department of Agriculture, Washington, D.C. 20250. Include your ZIP Code.

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<sup>3</sup> For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price \$1.45.

It is important to remember that fat is an important constituent of the diet and is important to health in many ways.

Fat is the most concentrated source of food energy. It supplies 9 calories per gram; protein and carbohydrate, the other two sources of food energy, supply 4 calories per gram. (Alcohol supplies 7 calories per gram.)

Fats are the chief sources of essential fatty acids (EFA's) as well as carriers of some essential vitamins, namely A, D, E, and K. Too little fat can result in a diet that is deficient in these nutrients. In addition, a diet too restricted in fat lacks flavor and satiety value; it is bulky because a greater volume of food is needed to satisfy the appetite and meet energy needs.

## VARIETY IN THE KINDS OF FAT OR FATTY ACIDS

Fatty acids are the building blocks of fat. Three molecules of fatty acid combined with one molecule of glycerol constitute a molecule of fat. This is called a triglyceride, the form in which fat is stored in adipose tissue.

Fats are classified as saturated or unsaturated depending on the kind of fatty acids present. Most food fats are a combination of the different saturated and unsaturated fatty acids.

A chemist describes a fatty acid as saturated if its chain of carbon atoms contains all the hydrogen it can hold (or if there are no double bonds between carbon atoms). The most common saturated fatty acids are myristic acid and palmitic acid. Saturated fats are usually hard at room temperature. They occur in both animal and vegetable fats, but chiefly in animal fats.

A chemist describes a fatty acid as unsaturated if its chain of carbon atoms has one or more double bonds where hydrogen could be added. The process of adding hydrogen to a double bond in an unsaturated fatty acid to make

it more saturated is referred to as hydrogenation.

Monounsaturated fatty acids have only one double bond where hydrogen could be added. Oleic acid is the most common monounsaturated fatty acid.

Polyunsaturated fatty acids have two or more double bonds where hydrogen could be added.

Polyunsaturated fats are usually oils and are most abundant in plant seeds and fish oils. Nearly all fats from plant sources are unsaturated; the only major exception is coconut oil, which is highly saturated.

The most common polyunsaturated fatty acid is linoleic acid. In general, the degree of unsaturation of a food fat depends on how much linoleic acid it contains.

Linoleic acid is an essential nutrient and must be supplied by food because the body cannot make it. It is involved in the metabolism of cholesterol and has other functions that are evident but have not yet been clearly defined. The body's need for linoleic acid seems to be met when about

2 percent of the total calories are supplied by linoleic acid.

Arachidonic acid, found in animal fats, is another essential polyunsaturated fatty acid. It is present in fats in relatively small amounts but can be synthesized from linoleic acid by the body.

Sometimes it is suggested that saturated, monounsaturated, and polyunsaturated fats should each supply about one-third of the total

amount of fat in the diet. Although this amount of polyunsaturated fat would supply much more linoleic acid than 2 percent of the total calories, polyunsaturated fat may have a lowering effect on levels of cholesterol in the blood.

The fat content and the major fatty acid composition of commonly used sources of fat are shown in table 1.

## CHOLESTEROL

Cholesterol is a normal constituent of blood and tissues and is found in every animal cell. Some of the cholesterol in human blood and tissues is synthesized by the body and some is supplied by diet. The amount supplied by diet varies greatly depending on the kinds and amounts of foods included.

The amount of cholesterol in the diet is positively related to the amount of cholesterol in the blood. Ordinary diets are likely to supply 600 to 900 milligrams of cholesterol daily. A "low-cholesterol" diet usually provides about 300 milligrams of cholesterol daily. This amount is more difficult to achieve in the usual American diet and may well be lower than is necessary for a healthy individual on a well-balanced diet.

To date, studies have not shown convincingly that restriction of dietary cholesterol in the general population reduces the frequency of atherosclerosis. However, persons with atherosclerosis usually have higher blood cholesterol levels than persons without atherosclerosis; and persons with high cholesterol levels develop atherosclerosis more often than those with normal levels.

The approximate amounts of cholesterol in servings of selected foods are given in table 2 (p. 6). Foods of plant origin—such as fruits, vegetables, cereal grains, legumes, and nuts—do not contain cholesterol. They contain plant sterols, which have been shown to reduce blood cholesterol levels.

## WHAT WE KNOW

It has been more than 15 years since the controversy over the role of fats in cardiovascular disease began. During this time, thousands of research studies have been made

and many facts have been uncovered.

The utilization of fats in man is affected by many factors:

- By the food we eat all our lives and our state of nutrition.

TABLE 1.—Fat content and major fatty acid composition of selected foods (in decreasing order of linoleic acid content within each group of similar foods)

Food	Total fat	Fatty acids <sup>1</sup>		
		Saturated <sup>2</sup>	Unsaturated	
			Oleic	Linoleic
	Percent	Percent	Percent	Percent
<b>Salad and cooking oils:</b>				
Safflower.....	100	10	13	74
Sunflower.....	100	11	14	70
Corn.....	100	13	26	55
Cottonseed.....	100	23	17	54
Soybean <sup>3</sup> .....	100	14	25	50
Sesame.....	100	14	38	42
Soybean, specially processed.....	100	11	29	31
Peanut.....	100	18	47	29
Olive.....	100	11	76	7
Coconut.....	100	80	5	1
Vegetable fats—shortening.....	100	23	23	6-23
<b>Margarine, first ingredient on label: <sup>4 5</sup></b>				
Safflower oil (liquid)—tub.....	80	11	18	48
Corn oil (liquid)—tub.....	80	14	26	38
Soybean oil (liquid)—tub <sup>6</sup> .....	80	15	31	33
Corn oil (liquid)—stick.....	80	15	33	29
Soybean oil (liquid)—stick <sup>6</sup> .....	80	15	40	25
Cottonseed or soybean oil, partially hydrogenated—tub. <sup>6</sup> .....	80	16	52	13
Butter.....	81	46	27	2
<b>Animal fats:</b>				
Poultry.....	100	30	40	20
Beef, lamb, pork.....	100	45	44	2-6
<b>Fish, raw: <sup>6</sup></b>				
Salmon.....	9	2	2	4
Mackerel.....	13	5	3	4
Herring, Pacific.....	13	4	2	3
Tuna.....	5	2	1	2
<b>Nuts:</b>				
Walnuts, English.....	64	4	10	40
Walnuts, black.....	60	4	21	28
Brazil.....	67	13	32	17
Peanuts or peanut butter.....	51	9	25	14
Pecan.....	65	4-6	33-48	9-24
Egg yolk.....	31	10	13	2
Avocado.....	16	3	7	2

<sup>1</sup> Total is not expected to equal total fat.

<sup>2</sup> Includes fatty acids with chains from 8 through 18 carbon atoms.

<sup>3</sup> Suitable as salad oil.

<sup>4</sup> Mean values of selected samples and may vary with brand name and date of manufacture.

<sup>5</sup> Includes small amounts of monounsaturated and diunsaturated fatty acids that are not oleic or linoleic.

<sup>6</sup> Linoleic acid includes higher polyunsaturated fatty acids.



● By our endocrine system—thyroid, adrenal, pituitary, ovarian, pancreatic, and other glands.

● By how active we are. Exercise increases the oxygen supply to the tissues, improves circulation, and relieves tension.

● By our emotional characteristics and our reactions to the modern,

highly industrialized and technological environment.

● By our aging. Aging means that physiological processes slow down, enzyme mechanisms become unable to keep up with the usual pattern of eating, and some tissues throughout the body become less active.

TABLE 2.—Cholesterol content of common measures of selected foods (in ascending order) <sup>1</sup>

Food	Amount	Cholesterol
		<i>Milligrams</i>
Milk, skim, fluid or reconstituted		
dry.....	1 cup	5
Cottage cheese, uncreamed.....	½ cup	7
Lard.....	1 tablespoon	12
Cream, light table.....	1 fluid ounce	20
Cottage cheese, creamed.....	½ cup	24
Cream, half and half.....	¼ cup	26
Ice cream, regular, approximately		
10% fat.....	½ cup	27
Cheese, cheddar.....	1 ounce	28
Milk, whole.....	1 cup	34
Butter.....	1 tablespoon	35
Oysters, salmon.....	3 ounces, cooked	40
Clams, halibut, tuna.....	3 ounces, cooked	55
Chicken, turkey, light meat.....	3 ounces, cooked	67
Beef, pork, lobster, chicken, turkey, dark meat.....	3 ounces, cooked	75
Lamb, veal, crab.....	3 ounces, cooked	85
Shrimp.....	3 ounces, cooked	130
Heart, beef.....	3 ounces, cooked	230
Egg.....	1 yolk or 1 egg	250
Liver, beef, calf, hog, lamb.....	3 ounces, cooked	370
Kidney.....	3 ounces, cooked	680
Brains.....	3 ounces, raw	more than 1700

<sup>1</sup> Source: "Cholesterol Content of Foods," R. M. Feeley, P. E. Criner, and B. K. Watt. J. Am. Diet. Assoc. 61:134, 1972.

● By our heredity. In some individuals a tendency to cardiovascular disease seems to be inherited. This does not mean that the disease is inevitable for those individuals. Neither does it mean that an apparent lack of a hereditary tendency guarantees the absence of the disease.

● By diseases that may interfere with the absorption and metabolism of fat.

We are certain that the body's utilization of fat and the role of fat in nutrition are affected by food constituents of all kinds and the interactions between them.

Diets high in fat can lead to above-normal amounts of lipids in the blood. (Lipids include triglycerides, fatty acids, cholesterol, and other fatlike substances.) A high level of blood lipids—especially of cholesterol—is associated with atherosclerosis. Evidence of a causal relationship, however, is lacking.

Diets with as much as 10 to 15 percent of the calories supplied by polyunsaturated fats frequently lead to a lowering of elevated blood cholesterol levels.

Many nutrients are important in fat utilization, including calcium, magnesium, chromium, zinc, vanadium, niacin, biotin, pantothenic acid, vitamin B<sub>6</sub>, and vitamin E. The involvement of these nutrients in fat metabolism has been established, although the specific action and quantitative requirement for some of them are not completely understood. For example, when the proportion of fat as polyunsaturated oils increases in the diet, the

requirement for vitamin E increases.

The kind of carbohydrate in the diet can influence fat metabolism. Some studies have shown that a high sucrose intake can produce elevated blood lipid levels in laboratory animals and humans. However, some investigators do not think that the tissue changes which result from feeding high amounts of sucrose are characteristic of atherosclerosis.

There are still many things we do not know about the effects of dietary fat on health. Some aspects on which additional basic information is needed are:

● The body processes that control the handling of fat and cholesterol that come both from the diet and from synthesis in tissues.

● How these processes are influenced by diet and other factors, including emotional and modern environmental factors.

● The upper and lower limits of the amounts of polyunsaturated fats, cholesterol, and total fats needed in the diet for optimum health.

The Inter-Society Commission for Heart Disease Resources released a report in 1970 on "Primary Prevention of the Atherosclerotic Diseases."<sup>4</sup> This report recommends that people make some definite changes in their dietary habits, beginning in early childhood, in order to reduce the risk of coronary heart disease in later life.

The changes recommended include:

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<sup>4</sup> *Circulation*, Vol. XLII, December 1970.

● Adjusting caloric intake to maintain optimum weight.

● Reducing fat intake so that fat supplies less than 35 percent of the total calories.

● A daily intake of less than 10 percent of the total calories from saturated fat and up to 10 percent from polyunsaturated fats, with the remainder of fat supplied by mono-unsaturated fats.

● A daily intake of less than 300 milligrams of cholesterol.

The report also urges the medicinal control of hypertension and the elimination of cigarette smoking.

The Inter-Society report has sparked a great deal of discussion and controversy. The only point of general agreement is the unquestioned importance of maintaining optimal weight at every age. The most controversial points are the proportions of total fat and different kinds of fat, the amount of cholesterol, and the efficacy of reducing the amounts of fat and cholesterol in diets of normal, healthy people.

The Committee on Nutrition of the American Academy of Pediatrics<sup>5</sup> has issued a statement recommending against the adoption of dietary changes for all children as urged by the Inter-Society Commission. The Committee believes that such dietary intervention is warranted only in special situations where children have been diagnosed as having elevated blood lipids, usually hereditary.

For children with diabetes or a strong family history of diabetes

and children in families having a history of coronary heart disease, the Committee on Nutrition considers that no harm is known to occur from moderate dietary alteration along the lines recommended by the Inter-Society Commission, and there may be some benefits.

Progress has been made in defining abnormalities resulting in elevated levels of cholesterol and other fats in the blood, the significance of these different types in the development of atherosclerosis, and their treatment. Heredity plays an important role in the occurrence of the different types.

It is now possible for physicians to screen individuals to determine whether they have elevated blood lipid values, the type of abnormality, and whether dietary changes or medication are indicated. Many physicians and scientists think that specific diagnosis and medically supervised treatment hold great promise for reducing the incidence of and mortality from atherosclerosis.

The Food and Nutrition Board of the National Academy of Sciences-National Research Council and the Council on Foods and Nutrition of the American Medical Association issued the following joint statement on "Diet and Coronary Heart Disease" in July 1972:

Coronary heart disease is the major public health problem in the United States and in many other countries. In 1970, for example, some 666,000 Americans, of whom about 171,000 were under the age of 65, died of coronary heart disease (CHD) and many more were disabled by the same disorder.

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<sup>5</sup> Pediatrics, Vol. 49, 305, 1972.

It is particularly disturbing that many relatively young Americans in their most productive years are killed or incapacitated by this disease.

Epidemiologic, experimental, and clinical investigations have identified a number of "risk factors" associated with susceptibility to CHD that can be manipulated. These include an elevation in plasma lipids, especially plasma cholesterol, high blood pressure (hypertension), heavy cigarette smoking, obesity, and physical inactivity. The evidence is not sufficient to quantitate the benefits that may be expected to come from modifying these various risk factors, but the seriousness of the situation demands that all reasonable means be used to reduce the conditions that contribute to risk of CHD.

There is abundant evidence that the risk of developing CHD is positively correlated with the level of cholesterol in the plasma. This risk, independent of other risk factors mentioned above, is relatively small at levels less than 220 mg/100 ml but increases progressively with each increment in plasma cholesterol above this level.

Approximately one-third of American men, and a less definitely known proportion of women, consuming their usual diets maintain plasma cholesterol levels at or below 220 mg/100 ml. There is extensive evidence that the level of cholesterol in the plasma of most people can be lowered by appropriate dietary modification.

Generally, such lowering can be achieved most practicably by partial replacement of the dietary sources of saturated fat with sources of unsaturated fat, especially those rich in polyunsaturated fatty acids, and by a reduction in the consumption of foods rich in cholesterol.

Preliminary evidence suggests that faithful and continued consumption of a cholesterol-lowering diet over a period of years can reduce the coronary attack rate in middle-aged men. As would be expected in dealing with a chronic disease of this kind, early intervention appears to be more effective than intervention after the disease is evident.

Elevation of other plasma lipids

(plasma triglycerides) also imposes an increased risk of CHD. The elevation of plasma triglycerides is often, but not always, associated with an elevation of plasma cholesterol. Plasma triglycerides can also be modified by dietary intervention. Although there are as yet no satisfactory epidemiologic data to support the conclusion that triglyceride-lowering diets can reduce the occurrence of CHD in persons with hypertriglyceridemia, the inference from clinical studies that such a reduction can be anticipated is strong.

In summary, the average level of plasma lipids in most American men and women is undesirably elevated. The importance of lowering the plasma cholesterol in any individual depends in large part upon his usual plasma cholesterol concentration.

The evidence now available is sufficient to discourage further temporizing with this major national health problem. Therefore, the Food and Nutrition Board and the Council on Foods and Nutrition recommend that:

(1) Measurement of the plasma lipid profile, particularly plasma cholesterol, become a routine part of all health maintenance physical examinations. Such measurements should be made in early adulthood, when coronary heart disease is still rare, and repeated at appropriate intervals. The potential impact of other risk factors should also be periodically assessed.

(2) Persons falling into "risk categories" on the basis of their plasma lipid levels be made aware of this and receive appropriate dietary advice. Such advice may vary somewhat with the nature of the blood lipid profile. [Frederickson, Levy, and Lees, *N. Eng. J. Med.* 276:34 (1967); Lees and Wilson, *N. Eng. J. Med.* 284:186 (1971); Report of Inter-Society Commission for Heart Disease Resources, *Circulation XLII*:A55 (1970); American Health Foundation Position Statement on Diet and Coronary Heart Disease, *Preventive Medicine 1*:255 (1972).] As indicated above, Americans should be advised to maintain a desirable body weight by an appropriate combination of physical activity and calorie intake.

In "risk categories" it is important to decrease substantially the intake of saturated fat and to lower cholesterol consumption. In practice, this entails substituting polyunsaturated vegetable oils for part of the saturated fat in the diet.

(3) Care be taken to assure that the dietary advice given does not compromise the intake of essential nutrients. Desirable intakes of nutrients are indicated in the Recommended Dietary Allowances (Nat. Acad. Sci. Publ. No. 1694, 1968).

(4) Since the foregoing recommendations will be effective only if they can be

accomplished with relative ease, modified and ordinary foods useful for this purpose be readily available on the market, reasonably priced, and easily identified by appropriate labeling. Any existing legal and regulatory barriers to the marketing of such foods should be removed.

(5) High priority be given to the conduct of studies that will determine reliably the extent to which the modification of plasma lipids, by dietary or other means, as well as modification of other risk factors, can reduce the risk of developing coronary artery disease.

## MODIFYING FOODS

A great deal of research is being done by USDA, universities, and food industries to develop ways to modify the kinds of fat, and especially to reduce the amount of fat, in meat and dairy products and in processed foods such as bakery goods and other convenience food items.

Many of these foods are already available in the market-place—lean meat; low-fat milk, cheese,

and ice cream; and salad dressings with a high proportion of polyunsaturated vegetable oil. These foods offer increased variety to consumers and are of special help to persons with specific dietary needs. The acceptability of products and their continued use by consumers will determine their future availability and their effect on the diet and health of the population.

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