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Nutrition Viewpoint - Fats Diets and Your Health  
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# NUTRITION VIEWPOINT

On the Everchanging Field of Human Nutrition

MICHIGAN  
STATE  
UNIVERSITY

Cooperative  
Extension Service



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## *fats, diets & your health*

BY GILBERT A. LEVELLE AND ANITA DEAN

FAT IS AN IMPORTANT NUTRIENT in the human diet. It is the most concentrated source of energy. On an equal-weight basis, it provides more than two times the energy in carbohydrate and protein—9 calories from a gram of fat, compared with 4 calories from carbohydrate and protein.<sup>1</sup>

### Fat in U.S. Diet

Fat consumption in the United States has increased significantly over the past 65 years. This includes fats and oils, as such, and fats occurring naturally in foods—examples are butterfat in milk, marbling in meat, and oils in nuts and seeds.

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The proportion of calories derived from fat in the U.S. diet has increased over the last 70 years as we have increased our consumption of animal products and decreased our consumption of cereal grains and potatoes, which are low in fat. (See chart on page 2).

Today, fat supplies 40 percent or more of total calories in the average American diet. Three food groups—fats and oils; meat, poultry and fish; and dairy products—account for about nine-tenths of the fat in the U.S. diet. Not all of the fat available for consumption is eaten. For example, some fat used in deep-fat frying by industry or in the home may be discarded; fat may be trimmed from meat either before or after cooking.

The vegetable-fruit group (except olives and avocados) and the bread-cereal group are very low in fat.

Fat is part of virtually all foods. Some foods such as butter, vegetable oil and margarine are nearly 100 percent fat. These are called “visible” fats. Those found in whole milk, cream, ice cream, cheese, egg yolk, meat, nuts, pastries and food mixtures are “invisible.” The milk-and-meat group furnishes about half the fat in the American diet. Even though all visible fat is trimmed off meats, cooked lean meat still contains 4 to 15 percent hidden fat. Choice cuts and higher grades that are well marbled with fat furnish higher amounts of fat.

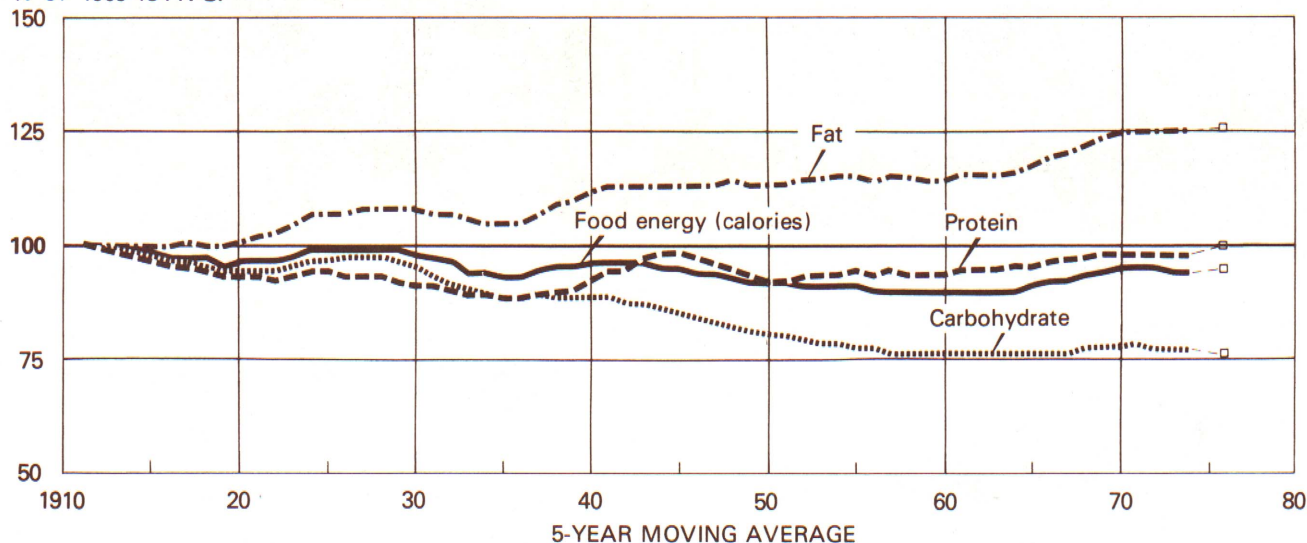
The **type** of fat consumed over the past 65 years has also changed. Daily dietary fat from animal sources (mostly **saturated**)<sup>2</sup> has decreased 8 percent while consumption of vegetable fat (**unsaturated**)<sup>2</sup> has dramatically increased by 57 percent. Increased consumption of margarine and salad and cooking oils accounts for this increase. Although the increase has come from foods of vegetable origin, animal sources continue to provide the largest proportion of fat in the diet.

<sup>1</sup>Alcohol contributes 7 calories per gram.

<sup>2</sup>See *Technical Discussion*, beginning on page 5.

## CONSUMPTION OF FOOD ENERGY, PROTEIN, FAT, AND CARBOHYDRATE

% OF 1909-13 AVG.



PER CAPITA CIVILIAN CONSUMPTION. □ 1976 PRELIMINARY.

### FAT CONTENT OF VARIOUS FOODS

Percent Fat	FOOD
90—100	Salad and cooking oils and fats, lard
80— 90	Butter, margarine
70— 80	Mayonnaise, pecans, macadamia nuts
50— 70	Walnuts, dried unsweetened coconut meat, almonds, bacon, baking chocolate
30— 50	Broiled choice T-bone and porterhouse steaks, spareribs, broiled pork chop, goose, cheddar and cream cheeses, potato chips, french dressing, chocolate candy, butter cream icing.
20— 30	Choice beef pot roast, broiled choice lamb chop, frankfurters, ground beef, chocolate chip cookies
10— 20	Broiled choice round steak, broiled veal chop, roast turkey, eggs, avocado, olives, chocolate cake with icing, french fried potatoes, ice cream, apple pie
1— 10	Pork and beans, broiled cod, halibut, haddock, and many other fish, broiled chicken, crabmeat, cottage cheese, beef liver, milk, creamed soups, sherbet, most breakfast cereals
Less than 1	Baked potato, most vegetables and fruits, egg whites, chicken consomme

### Are Fats Necessary in Your Diet?

Fat is a concentrated source of energy. It also makes foods tasty and provides that feeling of satisfaction not available from carbohydrate and protein. Fats are responsible also for many of the characteristic flavors, aromas and textures of foods, and they serve as carriers of vitamins A, D, E and K.

Fats (also called **lipids**) are made up of fatty acids (see Technical Discussion). The body cannot manufacture certain essential fatty acids; and, if these are lacking, a skin condition like eczema could develop. Such a condition, however, is extremely unlikely with usual American diets today which provide abundant amounts of fatty acids. In fact, it is unlikely under ordinary circumstances that any human diet will be low enough in fat to produce a critical lack of essential fatty acids. Vegetable oil consumption has increased dramatically in recent years. For example, a tablespoon of most vegetable oils, except peanut and olive oils, will meet the daily requirements for essential fatty acids.

Fats and fat-related substances in the body include (besides fatty acids) **glycerides**, **phospholipids**, and **cholesterol**. (For a chemical description of these materials and a discussion of how the body digests and absorbs fats, see Technical Discussion.)

The human body can produce fats (lipids) from a variety of diet sources. Carbohydrate and protein can be transformed into fat in the liver, and this fat can then be transported and stored in the body.

## Fats and Your Heart

Fats are transported in the blood and lymph in combination with proteins. The combination is known as **lipoprotein**. Fats cannot be transported in the bloodstream unless they are made soluble. This change occurs in the intestine when fat combines with protein to form a type of lipoprotein known as **chylomicron** (see Technical Discussion). Other varieties of **lipoprotein** are formed in the liver. They differ from one another in their fat and protein composition. Those known as "low-density" lipoproteins have a higher proportion of lipid and less protein than the "high-density" lipoproteins. Generally, the low-density lipoproteins have more **triglyceride** and less **phospholipid** and **cholesterol** than do the higher-density lipoproteins. (See Technical Discussion.)

The amount and kinds of lipoproteins in the blood are important in evaluating the risk category of individuals with regard to diseases of the heart, blood vessels or circulation known as cardiovascular disease.

### What is Atherosclerosis?

Atherosclerosis is a common form of cardiovascular disease. In its earliest stage, fatty deposits build up and infiltrate the artery walls. As the disease progresses, the areas of infiltration become thicker, and fibrous material is deposited along with the fat. These areas eventually become calcified as calcium is deposited. As a consequence, the arteries lose their elastic nature and become rigid. In addition, the artery becomes partially obstructed. (The process is much the same as the buildup of lime in water pipes. The buildup decreases the capacity of the pipe to carry its normal flow of water.) In this latter stage, it is much more likely that a small blood clot may entirely block the vessel. When this occurs in the small vessels feeding the heart, the result is a heart attack or coronary. The blockage of a blood vessel in the brain results in a stroke.

The nature of this abnormal condition and its development is not well understood in spite of many studies. The disease is progressive, beginning in some cases in childhood and advancing through young adulthood, often reaching severe forms in the third to fourth decade of life. The disease is more common in men than in women of childbearing age; however, the incidence has increased in women in recent years.

### Risk Factors in Atherosclerosis

Studies over the last several decades have provided a means of identifying persons who are most likely

to suffer a coronary or a stroke. The three major risk factors are:

- cigarette smoking,
- hypertension (high blood pressure), and
- high blood cholesterol levels.

An individual having any one of these risk factors has a greater **statistical chance** of suffering a coronary or a stroke than a person who is not affected by these factors. Individuals having any two of the risk factors have an even greater chance, and individuals having all three risk factors have the greatest chance of being affected.

One should not, however, conclude from these statements based on medical statistics that all individuals having one or more risk factors will have a coronary or a stroke, or that individuals free from these risk factors cannot be affected. A number of other factors appear to be important in predisposing individuals to atherosclerotic disease. One is a family history of the disease. Stress also appears to increase the probability of cardiovascular disease. Other contributing factors include overweight and an inactive lifestyle.

### Diet and Heart Disease

As indicated, a high blood cholesterol level is a risk factor in the development of cardiovascular disease. Several studies in a variety of countries have shown a higher incidence of heart disease in populations consuming a high proportion of calories from fat, particularly saturated fat, and having relatively high intakes of cholesterol and higher levels of cholesterol in the blood. Studies with animals show that experimentally induced atherosclerotic heart disease is higher in animals fed diets high in saturated fat and cholesterol.

Some studies with humans have shown that high blood cholesterol levels can be reduced through diets lower in actual amount of fat but containing a higher proportion of polyunsaturated fatty acids and less cholesterol (see Technical Discussion).

From these studies, some scientists conclude that the American population and others similar to it would benefit from consuming diets lower in cholesterol and in fat but containing a higher proportion of polyunsaturated fatty acids. But not all scientists agree with this conclusion. Why? It remains to be proven conclusively that lowering the blood cholesterol level by changes in diet will actually lower the incidence of cardiovascular disease. Considerable suggestive evidence has been collected, but not all

studies are in agreement. For example, studies have shown that those individuals who had suffered heart attacks did not necessarily have the highest cholesterol and fat intakes in the population under study. So, the matter of dietary change to control cardiovascular disease is not a simple one agreed to by all scientists and physicians. Much controversy still exists. Nevertheless, scientists generally agree that everyone should be examined periodically for abnormal blood lipid profiles and checked for hypertension (high blood pressure).

### **Some Tests to Take**

A blood sample should be taken for lipid analysis, including blood cholesterol and triglycerides; and in many cases, a lipoprotein analysis should be made. From this information, a physician can determine whether an abnormality exists and what it is. If one is found, a corrective diet can be prescribed.

Hypertensive persons should be treated to lower their blood pressure. Patients with elevated blood lipid levels should be treated to lower these levels to normal. In most cases, the treatment to lower blood lipid levels will involve a modification of diet.

Usually, two common abnormalities are found in the blood — high cholesterol and/or high triglycerides. The treatment of high cholesterol usually calls for less fat in the diet (approximately 35 percent of calories from fat), a reduction in saturated fat (no more than 10 percent of total calories), and a reduction in cholesterol (to 300 mg per day or less).<sup>3</sup>

Diet change to lower triglycerides in the blood is somewhat different. Those who have this problem usually are overweight, and a lower-calorie diet is recommended to return weight to normal. Also, treatment should call for a reduction in the proportion of calories derived from simple carbohydrates (sugar) and from alcohol. Other abnormalities in blood lipids can exist, but these are rare.

### **Changes in the General Diet**

Although there is no consensus regarding changes in the diet for restricting intake of fat for the general population, most scientists agree that some changes are probably desirable. Because so many Americans are overweight, a reduction in total dietary fat to reduce intake of calories would be desirable, and certainly would cause no harm. If this reduction in total fats could be achieved by reducing saturated fat, the

proportion of polyunsaturated fatty acids in the diet would increase automatically. This might also be desirable in controlling heart disease.

As a rule of thumb, it is probably desirable for most Americans to strive for about 15 percent of their calories from protein, 35 percent from fat and 50 percent from carbohydrate. This is moderate and achievable and is supported by research.

There is much less agreement on dietary cholesterol. Consequently, no general recommendation has been made for the population as a whole. However, everyone should avoid obviously high amounts of cholesterol. A balance of all nutrients in the diet requires a wide variety of basic foods — ample amounts of fruits and vegetables; dairy products; meat, fish, poultry and eggs; whole grain and enriched cereals. This variety of foods will also ensure that the carbohydrate in the diet comes largely from complex sources such as starches in cereal and potatoes, which furnish other nutrients as well, rather than simple sugars (table sugar and soft drinks, which contain little or no other nutrients) and sweet desserts such as rich pies and cakes. Current research findings suggest that increased intakes of complex carbohydrates may be desirable.

Such a change in diet need not involve a drastic change in eating habits. For example, the fat content of the diet can be significantly reduced by simply substituting low-fat milk for whole milk or ice milk for ice cream, or by trimming the fat from meat and selecting leaner cuts of meat. This does not require us to become compulsive about our eating habits; but a few relatively simple changes in the types of food products we eat can make a significant difference in fat consumption.

### **Sources of Information**

Patients on special diets can get specific information about diets and heart disease by consulting a dietitian recommended by their physician. In many communities, dietitians provide a service entitled "Dial-a-Dietitian." In some communities, public health nutritionists can be contacted through the Department of Public Health. State Cooperative Extension Services can also be of assistance through nutrition specialists and home economists. Although these nutritionists are not allowed to prescribe diets, they can assist individuals in meeting the recommendations prescribed by their physicians.

<sup>3</sup> See suggestion in "Sources of Information."

## technical discussion

### WHAT ARE FATS OR LIPIDS?

Fats (also called **lipids**) are organic chemical compounds. They will not dissolve in water but are soluble in other organic compounds such as alcohol. Fats are made up of **fatty acids**. Cholesterol and fat-soluble vitamins A, D, E and K are generally grouped with fats.

All fatty acids contain carbon, hydrogen and oxygen. They vary in how much of these three elements they contain. The most common fatty acids in foods have 16 or 18 carbon atoms. Others have fewer than 12.

Fatty acids vary also in the amount of hydrogen they contain. **Saturated** fatty acids contain more hydrogen than the **unsaturated**.

In each molecule of an unsaturated fatty acid, there is a double bond between two carbon atoms. The number of double bonds between carbon atoms determines the degree of unsaturation. A **mono-unsaturated** fatty acid has a single (mono-) double bond between carbon atoms, and a **polyunsaturated** fatty acid has two or more (poly-) double bonds.

Both the number of double bonds and the number of carbon atoms in a molecule of a fatty acid are of special importance: together they influence the nature of fatty acids by altering their melting points. This has very practical applications. Fatty acids with fewer carbon atoms tend to be liquid at room temperature. Those saturated fatty acids with more carbon atoms are solid at room temperature. The more-unsaturated

fatty acids (those with less hydrogen) have lower melting points and tend to be liquid, whereas the saturated fatty acids (with more hydrogen) are solid at room temperature.

The naturally unsaturated (lower-hydrogen) fatty acids, such as those found in vegetable oils, can be "hydrogenated;" that is, the double carbon bond can be broken, and hydrogen can be added. This process converts liquid vegetable oils into solid fats, such as margarines and shortenings.

### What Are Glycerides?

**Glycerides** are the major form of fat found in nature. They are made up of fatty acids and **glycerol**, which is a type of alcohol. A molecule of glycerol can be attached to one, two or three molecules of fatty acids. These can be mono-, di- or tri- glycerides. Most animal and vegetable fats are triglycerides.

The characteristics of a fat are determined by the kinds of fatty acids in its makeup. Liquid vegetable oils contain larger amounts of the unsaturated fatty acids, whereas the saturated fats, such as beef tallow, contain more saturated fatty acids. All fats, whether liquid or solid, are glycerides containing both saturated and unsaturated fatty acids. They differ only in the proportions of each.

### What Are Phospholipids?

**Phospholipids** are abundant in nature and are found in such foods as egg yolk and

### GLOSSARY OF TERMS RELATED TO FATS AND OILS

**Adipose tissue** (ADD-uh-pose) — Body fat.

**Arteriosclerosis** (ar-teer-eo-skluh-RO-sis) — Hardening of the arteries.

**Atherosclerosis** (ATH-uh-ro-skluh-RO-sis) — Condition where fatty deposits decrease the inside diameter of arteries and interfere with blood circulation.

**Blood lipid profile** (lip-ud) — Common clinical laboratory test to determine the level of special lipids (triglycerides and cholesterol) in blood.

**Cardiovascular disease** (CARD-eo-VASS-kyuh-ler) — Diseases related to the heart and the blood vessels.

**Cholesterol** (ko-LES-ter-awl) — Substance manufactured by the body which is also found in foods of animal origin.

**Chylomicron** (ki-lo-MY-cron) — Very low-density lipoprotein (high in lipid).

**Emulsify** (e-MULL-suh-fy) — To convert into an emulsion (small particles of fat dispersed in liquid).

**Essential fatty acid** — Polyunsaturated fatty acid which the human body requires but cannot manufacture.

**Fat-soluble vitamins** — Vitamins A, D, E, K.

**Fatty acid** — Basic unit (building block) of fat. Each fatty acid molecule consists of a string of carbon atoms to which are attached hydrogen and oxygen atoms in a specific pattern. There are three families of fatty acids: polyunsaturated, mono-unsaturated and saturated.

**Glyceride** (GLISS-uh-ride) — Chemical compound formed from glycerol and one or more fatty acids.

**Glycerol** (GLISS-uh-rawl) — A water-soluble alcohol capable of combining chemically with up to three molecules of fatty acid to form compounds known as gly-

liver. They are a group of complex fats containing glycerides (glycerol and fatty acids) and phosphorus and nitrogen compounds. Lecithin is a phospholipid found commonly in nature and in foods such as egg yolk, beef liver, meats, whole grains, legumes, milk and vegetables, and is also available as a commercial product. Phospholipids serve to emulsify the triglycerides in digestion and absorption (breaking them up into small particles) so the blood can carry them. This process is discussed in more detail in a following section.

Phospholipids are added in the commercial processing of certain foods because of their emulsifying property; examples are egg yolk in preparing mayonnaise, soya lecithin in chocolate candy and some commercial baked products.

### What Is Cholesterol?

Cholesterol is an alcohol compound found in animal tissues. Similar compounds found in plants are quite different and are of no concern in the diet. Cholesterol is derived from a variety of animal foods and can also be manufactured by the body. It is abundant in eggs, organ meats (liver, kidney) and in nervous tissues such as brain. Cholesterol is an important part of nervous tissue and cell membranes. It is essential for the development of sex hormones and bile acids. The latter are important in the digestion and absorption of fats from the intestine.

### Digestion and Absorption of Fats

Let us follow a fat through the digestive process. It will pass through the mouth and stomach virtually unchanged. In the intestine it is mixed with liver bile which emulsifies it, breaking it up into extremely small particles. The tiny fat particles are then attacked by lipase, an enzyme secreted from the pancreas. This enzyme breaks down the fat particles into free fatty acids and glycerol (the two components of glyceride). Certain fatty acids (those with fewer than 12 carbon atoms) are absorbed through the intestinal wall directly into the bloodstream and are carried to the liver. Other fatty acids and monoglycerides are absorbed into the intestinal cells of the intestinal wall where they are recombined into triglycerides. The triglycerides then combine with protein to form larger fat particles called **chylomicrons**, a form of **lipoprotein**. These enter the lymphatic system and eventually enter the bloodstream and are carried to body fat. In the adipose tissue they are recombined as a triglyceride for storage. Both in the bloodstream and in adipose tissue, they are available to other tissues as a source of energy.

Some fat in the diet is essential as a carrier of the fat-soluble vitamins and to insure their proper absorption. During the process of fat absorption, the fat-soluble vitamins are transported directly into the bloodstream from the intestine. A totally fat-free diet would likely not only be low in fat-soluble vitamins but would also lead to impaired absorption of these vitamins.

cerides and with a nitrogenous base and phosphorus to form phospholipids.

**Lecithin** (LESS-uh-thin) — A phospholipid. These naturally occurring glycerides containing phosphorus and nitrogen mix well with both fat and water. They are useful emulsifying agents.

**Lipase** (LIE-paze) — Fat-splitting enzyme in the blood, pancreatic secretion and tissues.

**Lipid** (LIP-ud) — Class of chemical compounds that contain fats, sterols and phospholipids. (The word scientists use when they talk about fat.)

**Lipoprotein** (lip-o-PRO-tee-in) — Chemical form in which fat is transported in blood (composed of fat and protein).

**Monoglyceride** (mah-no-) — Glycerol combined with one fatty acid. Monoglycerides are formed during the digestion of triglycerides in the intestinal tract and may also be produced commercially from fat. Monoglycer-

ides are more soluble in water than triglycerides and, therefore, are frequently used as emulsifying agents to prevent the separation of fat and water mixtures.

**Obesity** (oh-BEE-sitsee) — Excessive accumulation of body fat.

**Phospholipid** (FAHSS-fo-lip-ud) — Class of lipids containing nitrogen and phosphorus. They are important components of most plant and animal cells.

**Polyunsaturated** (polly-un-SATCH-uh-rated) — Fatty acid having space for two or molecules of hydrogen.

**Mono-unsaturated** (mah-no-un-) — Fatty acid with space for one molecule of hydrogen.

**Saturated** (SATCH-uh-rated) — A fatty acid with hydrogen at every available spot in the molecule.

**Triglyceride** (try-GLISS-uh-ride) — The chemical compound formed from glycerol and three fatty acids. All fats and oils are mixtures of triglycerides and very small amounts of other lipids.

**Unsaturated** — A fatty acid lacking some hydrogen.