A NUTRITION PRIMER: FAT AND CHOLESTEROL

LARRY W. GREENLY^a

^aPrivate Practice of Chiropractic, Albuquerque, NM.
Submit requests for reprints to: Larry W. Greenly, 2916 Jane Ct NE,
Albuquerque, NM 87112. Email: drdoom999@juno.com Paper submitted
November 11, 2000.

INTRODUCTION

Chiropractic patients, like the rest of the public, are bombarded daily with confusing and sometimes conflicting data about nutrition. Many patients are bewildered—and, no doubt, so are some doctors. This article will give a nutritional overview of 2 components of diet—fat and cholesterol—to assist doctors in answering questions from their patients about this important topic that may affect their health.

NECESSARY COMPOUNDS

Fat is a nutrient that is absolutely vital. Chemically speaking, fats and oils are both members of the same family of compounds called triglycerides, differing only in melting points. Fats are generally solid at room temperature, whereas oils are liquid. Oils, then, can be considered as liquid fats, and in this article will be referred to by the generic term, “fat.”

Fats supply energy (calories) to the body—as do proteins and carbohydrates—to power physical activity and to keep bodily processes functioning. Fat is a powerhouse, with a highly concentrated energy value of 9 cal/gm. By comparison, carbohydrates and proteins have an energy value of only 4 cal/gm.

Excess body energy is stored as fat in adipose tissue for later use as an extra energy source; one pound of fat can supply enough calories for 1-1/2 to 2 days of activity. An average woman is about 25% fat, while an average man is about 15% fat, but there is no upper limit to the amount of fat that a body can store. Who hasn't seen news stories of incredibly obese people having to rely on forklifts and dismantling of their homes in order to remove them and transport them to hospitals?

The fat-soluble vitamins, A, D, E, and K rely upon fats to dissolve and transport them throughout the body; layers of fat are used by the body to cushion and protect some inner organs; and other layers provide insulation against cold. Two types of fats are essential: linoleic acid and linolenic acid, which are crucial for growth and healthy skin. The body cannot manufacture them, so they are supplied by the diet.

Dietary fat is universally liked because it provides various flavor sensations, a mouth feel of smooth texture, and a sensation of long-lasting satiety or fullness after eating.

Despite some confusion, cholesterol is *not* fat. Technically, cholesterol is not even a nutrient because it cannot be broken down by the body and used as energy, but it's usually found in the company of fats.

Cholesterol is a fat-like substance that is absolutely necessary for human life. It's part of every cell, part of many hormones (including sex hormones), part of bile to help digest and absorb fat, and it's even the nucleus of vitamin D, playing a part in the skin's reaction to sunlight. As with many things in life, cholesterol has a downside. Too much of it may lead to cardiovascular disease.

Even if a person ingests no dietary cholesterol whatsoever, the body can manufacture enough cholesterol for its needs. The liver produces the majority of it, but every cell in the body can also make it. Health problems like arteriosclerosis occur when the body has too much serum cholesterol. The excess is deposited throughout fat cells and some may build up on the walls of arteries, forming plaque and narrowing the vessels.

WHAT IS FAT?

First, a little chemistry. Fats are chemical compounds consisting of carbon and hydrogen atoms. Three carbon atoms are arranged in a row to form a molecule of glycerol. If each carbon atom has a fatty acid attached to it, the result is a triglyceride (see Figure 1).

When fat is digested, it's broken down into the basic components of glycerol and fatty acids to form other fats

Figure 1: A glycerol molecule combines with a schematic representation of a fatty acid, forming a triglyceride and losing three molecules of water.

for use in various bodily functions. Excess fat is stored as triglycerides.

Upon heating a fat, one or more fatty acids may break off, becoming "free fatty acids." If only one breaks off, the resulting fat is called a "diglyceride," and if 2 break off, the fat is called a "monoglyceride."

Fats can contain any combination of short, medium or long-chain fatty acids. One configuration called omega-3 is particularly healthful. Highly polyunsaturated omega-3 fatty acids are useful in enhancing the immune system, lowering serum triglycerides, lowering LDL cholesterol (described below), and reducing the risk of blood clotting. High amounts of omega-3 fatty acids are found in fatty fish like bluefish, mackerel, trout, herring, tuna, and salmon.

The carbon atoms in fatty acids have 4 bonds that can be used to attach to other atoms. If all the bonds are used (and no spaces are left), they are called *saturated fatty acids* (see Figure 2). The main source of saturated fatty acids is from animal foods, such as meat and dairy products, but certain plant sources like tropical oils (coconut, palm, and palm kernel) also contain very large amounts of saturated fatty acids.

Figure 2: A saturated fatty acid with all carbon bonds filled.

Saturated fats are solid at room temperature. They tend to be more stable than their unsaturated counterparts because their carbon atoms have all four bonds filled, preventing them from reacting with other substances. Food processors like them because they taste good, have a longer shelf life, and don't turn rancid easily.

Unsaturated fats can be converted into hydrogenated fats by bubbling hydrogen through them. Most hydrogenated fats are 5 to 50% saturated, which gives them a semi-solid consistency.

The normal chemical shape of a fat is called the *cis-configuration*; hydrogenation converts the *cis* configuration to a different shape called a *trans-configuration*. *Trans*-fatty acids have been implicated in raising serum cholesterol in a manner similar to the action of saturated fats. For that reason, some manufacturers have begun eliminating *trans*-fatty acids from their margarines and other products.

Sometimes a carbon atom forms a single double bond with another carbon atom, eliminating a pair of hydrogen atoms to form a *monounsaturated* fatty acid (see Figure 3). Canola (rapeseed) oil, nut oils, and olive oil

Figure 3: A monounsaturated fatty acid with one carbon double bond and one pair of hydrogen atoms missing.

are high in monounsaturated fatty acids. Monounsaturated fatty acids are liquid at room temperature.

If 2 or more carbon atoms form double bonds, thereby eliminating 2 or more hydrogen pairs, the result is a *polyunsaturated* fatty acid (see Figure 4). Vegetable oils from corn, safflowers, soybeans, and sunflowers, and the fats in seafood are high in polyunsaturated fatty acids. Poly-fatty acids are liquid or soft at room temperature.

An very important rule to remember is that *all* fats contain saturated, monounsaturated, and polyunsaturated fatty acids; only the proportions vary (see Table 1).

LOWERING CHOLESTEROL

Not too long ago, it was thought that cholesterol was just cholesterol. Now we know that cholesterol has several forms—the 2 of interest in this article are HDL cholesterol and LDL cholesterol. Cholesterol, which is fat soluble, is carried throughout the bloodstream by particles of fat and protein called *lipoproteins*. Total serum cholesterol is the sum of high-density lipoproteins (HDL) and low-density lipoproteins (LDL).

Studies indicate that a desirable range of total cholesterol is less than 200 mg/100 ml of blood. A more useful risk indicator is the ratio of total cholesterol to HDLs. A ratio of 5 is a standard risk; 3.5 is half the standard risk; 10 is double; and 20 is triple. A good goal to reach is a ratio of 4 or less. Another risk indicator is LDL levels go above 130, or HDL levels drop below 35: an HDL level of more than 70 is considered protective.

Many people, including doctors, commonly refer to HDL as “good cholesterol” and LDL as “bad cholesterol.” HDLs scavenge cholesterol as they circulate through the bloodstream. LDLs tend to accumulate in arteries as plaque and contribute to arteriosclerosis.

Surprisingly, eating cholesterol does not necessarily translate into increased serum cholesterol. Remember,

Figure 4. A polyunsaturated fatty acid with two carbon double bonds and two pairs of hydrogen atoms missing.

the liver (and other cells) produce all the cholesterol the body needs. Several studies have shown that eating additional cholesterol makes little difference in serum cholesterol levels (while on a low-fat diet). Evidently, the liver merely reduces its production to keep serum levels constant.

Saturated fat is the real villain. It actually stimulates the liver to produce more cholesterol whether or not it's needed. On the other hand, eating fats high in monounsaturated fatty acids lowers LDLs without affecting the HDLs, whereas eating fats high in polyunsaturated fatty acids lowers both LDLs and HDLs.

What nature giveth, though, the food processors taketh away. As mentioned above, sometimes the good mono- and poly-fats are hydrogenated to produce an artificial compound with trans-figured fatty acids that raise LDLs as if they were saturated fats. Examine food labels; if “partially hydrogenated” is mentioned, then trans- fats are present (see Table 2).

LOWER CHOLESTEROL BY LOWERING FAT

The 4 major controllable risk factors of heart disease include high serum cholesterol, high blood pressure, smoking, and inactivity. Modifying these risk factors can prevent and even reverse cardiovascular disease.

The best way to lower cholesterol levels is to limit overall fat content because cholesterol is usually associated with high levels of fat, particularly the villainous saturated fats. Undeveloped countries have about 10% of their caloric intake in the form of fats; industrialized nations have closer to 40%—and rates of cardiovascular disease show a correlation. A healthful goal is to lower total fat intake to 30% of calories or less per day (but not less than 15–20%) and limit cholesterol intake to 300 mg or less.

Such a diet is best attained by not limiting intake to only individual foods containing less than 30% fat, but by balancing high- and low-fat foods so the net result at the end of the day is the desirable 30%. A fat budget with allowances based on grams, rather than calories, is easier for a patient to keep track of fat intake (see Table 3).

WHAT ABOUT EGGS?

Recent studies indicate that eggs may not be so bad for you, after all. If a moderate intake of several eggs per week is coupled with a low-fat diet, serum cholesterol is not significantly altered.

TABLE 1
PERCENT MONO-, POLY-, SATURATED FATS AND CHOLESTEROL IN OILS AND FATS

TYPE	% MONOUNSATURATED	% POLYUNSATURATED	% SATURATED	% CHOLESTEROL
HAZELNUT OIL	78	10	7.4	0
OLIVE OIL	74	9	14	0
CANOLA OIL	58	36	6	0
PEANUT OIL	46	32	17	0
LARD	46	12	40	12
VEG. SHORTENING	45	25	26	0
CHICKEN FAT	45	21	30	11
BEEF TALLOW	42	4	50	14
RICE OIL	42	38	19	0
MARGARINE, STICK	39	24	14	0
PALM OIL	37	10	50	0
MARGARINE, TUB	32	31	14	0
BUTTER OIL	29	4	62	33
CORN OIL	25	59	13	0
SOYBEAN OIL	24	58	15	0
SUNFLOWER OIL	20	66	11	0
COTTONSEED OIL	18	52	26	0
WHEAT GERM OIL	15	63	19	0
SAFFLOWER OIL	12	75	9	0
PALM KERNEL OIL	11	2	81	0
COCONUT OIL	6	2	87	0

This is good news because eggs are nutritional powerhouses. One large egg has only about 75 calories, but it contains more than a dozen vitamins and minerals, with the exception of vitamin C. Its yolk contains all the fat (about 4.5 gm) and all the cholesterol (190 mg); its white has no fat or cholesterol. About two-thirds of the yolk's fat are monounsaturates and polyunsaturates. The yolk also contains the emulsifier, lecithin.

WHAT ABOUT SHRIMP?

Shellfish are high in cholesterol, but because they contain omega-3 fatty acids, they may actually help lower cholesterol levels. The most important factor, however, is that shellfish are extremely low in saturated fat. One study showed that eating crabs, clams, mussels, and oysters lowered LDLs and raised HDLs, while shrimp and squid had a neutral effect (see Table 4).

SUGGESTIONS FOR TRIMMING FAT

As said above, trimming fat from the diet is the first step in lowering cholesterol. Because all 3 saturated, monounsaturated, and polyunsaturated fats occur naturally in foods, total fat intake should be divided equally among the 3 types, i.e., for a goal of 30% total fat calorie intake, 10% should be saturated fat, 10% should be monounsaturated and 10% should be polyunsaturated.

Some suggestions for patients wanting to trim away fat and cholesterol include:

1. Not avoiding any one food, but including it in an overall variety of foods that add up to a daily or weekly intake of 30% or less of total calories.
2. Eating lean meats and trimming away visible fat and skin.
3. Eating more fish.
4. Eating more fruits and vegetables.
5. Eating more grains, particularly those with soluble fiber.
6. Choosing low-fat or nonfat dairy products.
7. Lowering intake of fats and oils.
8. Choosing low-fat or nonfat food products.
9. Changing cooking style from frying to broiling, steaming, baking, or boiling.
10. Seasoning foods with herbs and spices instead of high-fat flavorings.
11. Watching portion sizes.
12. Using liquid or soft versions of oils and margarines, when possible, to reduce intake of saturated fats.
13. Limiting intake of high-cholesterol organ meats.
14. Moderating use of whole eggs, or using only the whites.
15. Reading food labels to determine amounts of fat and cholesterol.

SOME NEW FAT REPLACERS

A number of people who embark upon low-fat diets miss the desirable taste, texture, and appearance that fats give to foods. Manufacturers have responded to this desire by developing different types of fat replacers. Fat replacers generally have fewer calories than the fats

TABLE 2
FAT AND CHOLESTEROL LABEL TERMS

FAT CONTENT	
FAT FREE	(<0.5 GM FAT/SERVING)
LOW FAT	(3 GM FAT/SERVING)
REDUCED OR LESS FAT	(25% LESS FAT/SERVING THAN STANDARD VARIETY)
LIGHT	(1/3 FEWER CALORIES OR 50% LESS FAT/SERVING THAN STANDARD VARIETY)
N% FAT FREE	(FOOD MEETS DEFINITION OF LOW FAT OR FAT FREE, IF 100% FAT FREE)
LIGHT MEAL	(LOW FAT: 50% LESS FAT/SERVING OR LOW CALORIE: 1/3 FEWER CALORIES/SERVING)
LOW-FAT MEAL	(3 GM FAT/100 GM AND 30% LESS CALORIES FROM FAT)
SATURATED FAT CONTENT	
SATURATED FAT FREE	(<0.5 GM SATURATED FAT AND <0.5 GM TRANS- FATTY ACIDS/SERVING)
LOW SATURATED FAT	(1 GM SATURATED FAT/SERVING AND 15% CALORIES FROM SATURATED FAT)
REDUCED OR LESS SATURATED FAT	(25% LESS SATURATED FAT THAN STANDARD VARIETY)
CHOLESTEROL CONTENT	
CHOLESTEROL FREE	(<2 MG CHOLESTEROL AND 2 GM LESS SATURATED FAT/SERVING)
LOW CHOLESTEROL	(20 MG LESS CHOLESTEROL AND 2 GM LESS SATURATED FAT/SERVING)
REDUCED OR LESS CHOLESTEROL	(25% LESS CHOLESTEROL THAN STANDARD VARIETY AND 2 GM SATURATED FAT/SERVING)
FAT, SATURATED FAT, AND CHOLESTEROL CONTENT OF SEAFOOD, MEAT, OR POULTRY	
LEAN	(<10 GM TOTAL FAT, 4.5 GM SATURATED FAT, AND 95 MG CHOLESTEROL PER 3 OZ SERVING AND PER 100 GM)
EXTRA LEAN	(<5 GM TOTAL, 2 GM SATURATED FAT, AND 95 MG CHOLESTEROL PER 3 OZ SERVING AND PER 100 GM)

they replace. Most reduced-fat or fat-free products contain a mixture of fat replacers to most closely imitate the replaced fat.

Carbohydrate-based fat replacers have modified starches, dextrins, cellulose, and gums combined with water to provide a thicker texture and appearance. Fat-free salad dressings are a good example of this type.

Protein-based fat replacers have egg whites or skim milk to provide a creamy mouth feel and improve texture and appearance when replacing fat. Simplese® is one brand; it has 1–2 calories/gm.

Fat-based replacers have chemically-altered fats that provide few or no calories because the body cannot

TABLE 3
FAT BUDGET GUIDELINES

TOTAL DAILY CALORIES	TOTAL FAT CALORIES	MAXIMUM DAILY FAT INTAKE (GM)
1,200	360	40
1,400	420	47
1,600	480	53
1,800	540	60
2,000	600	67
2,200	660	73
2,400	720	80
2,600	780	87
2,800	840	93
3,000	900	100
3,200	960	107

TABLE 4
SEAFOOD FAT AND CHOLESTEROL CONTENT

3 OZ. SERVING	CHOLESTEROL (MG)	SATURATED FAT (GM)
SHRIMP	166	0.25
OYSTERS	93	1.07
CRAB, BLUE	85	0.19
LOBSTER	61	0.09
CLAMS	57	0.16
MUSSELS	48	0.72
SCALLOPS	28	0.07

digest them. Olestra (OLEAN®) is one example made from vegetable oils and sugar. Because olestra isn't digested, some fat-soluble vitamins are not fully absorbed. For this reason, foods made with olestra have added fat-soluble vitamins. Be aware that some people may experience digestive problems when eating large amounts of olestra.

LOWERING CHOLESTEROL

Once fat levels are under control, there are a number of promising dietary substances under study that may lower serum cholesterol, including one regimen used anecdotally with some success: 1500 mg time-release niacin and the equivalent of 3 tablespoons of oat bran in divided doses per day. The oat bran may be ingested alone or in other food products. Both the niacin and oat bran should be gradually increased to the suggested amounts to allow the body time to adjust.

Other substances that may lower cholesterol include:

1. Barley flour or pearl barley used daily.
2. Garlic, with its compounds of quercetin and ajoene to help blood platelets from clumping and accumulating on arterial walls.
3. Grapefruit, with its soluble fiber, pectin, to help lower both total cholesterol and LDLs.

4. Oats, with its soluble fibers.
5. Prunes, with pectins, have demonstrated a small drop in LDLs.
6. Rice bran or rice bran oil.
7. Shellfish, with high levels of omega-3 fatty acids to help lower total cholesterol and LDLs; shrimp and squid have no effect.
8. Wines, with polyphenols, to help prevent blood platelets from clumping.

THE FINAL WORD

Moderation.

ADDITIONAL READINGS

1. Corriher, SO. Cookwise: the hows and whys of successful cooking. New York, NY: William Morrow and Company, Inc; 1997.
2. Duyff RL. The american dietetic association's complete food & nutrition guide. Minneapolis, MN: Chronimed Publishing; 1996.
3. Feltman J, ed. Prevention's food & nutrition. Emmaus, PA: Rodale Press; 1993.
4. McGee H. On food and cooking: the science and lore of the kitchen. New York, NY: Charles Scribner's Sons; 1984.
5. Pennington JAT, Church HN. Bowes and church's food values of portions commonly used. New York, NY: Harper & Row, Publishers; 1980.
6. Sonberg, L. The health nutrient bible: the complete encyclopedia of food as medicine. New York, NY: Simon & Schuster; 1995.