

# Saturated fat

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A **saturated fat** is a type of fat, in which the fatty acids all have single bonds.

A fat is made of two kinds of smaller molecules: monoglyceride and fatty acids. Fats are made of long chains of carbon (C) atoms. Some carbon atoms are linked by single bonds (-C-C-) and others are linked by double bonds (-C=C-).<sup>[1]</sup> Double bonds can react with hydrogen to form single bonds. They are called saturated, because the second bond is broken up and each half of the bond is attached to (saturated with) a hydrogen atom. Most animal fats are saturated. The fats of plants and fish are generally unsaturated.<sup>[1]</sup> Saturated fats tend to have higher melting points than their corresponding unsaturated fats, leading to the popular understanding that saturated fats tend to be solids at body temperatures, while unsaturated fats tend to be liquid oils.

Various fats contain different proportions of saturated and unsaturated fat. Examples of foods containing a high proportion of saturated fat include animal fat products such as cream, cheese, butter, other whole milk dairy products and fatty meats which also contain dietary cholesterol.<sup>[2]</sup> Certain vegetable products have high saturated fat content, such as coconut oil and palm kernel oil.<sup>[3]</sup> Many prepared foods are high in saturated fat content, such as pizza, dairy desserts, and sausage.<sup>[2][4]</sup>

The effect of saturated fat on risk of disease is controversial. Many reviews recommend a diet low in saturated fat and argue it will lower risks of cardiovascular diseases, diabetes, or death.<sup>[5]</sup> However, other reviews have rejected those arguments or advocated for examining the proportion of saturated to unsaturated fat in the diet.<sup>[6][7][8]</sup>

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## Fat profiles

While nutrition labels regularly combine them, the saturated fatty acids appear in different proportions among food groups. Lauric and myristic acids are most commonly found in "tropical" oils (e.g., palm kernel, coconut) and dairy products. The saturated fat in meat, eggs, cacao, and nuts is primarily the triglycerides of palmitic and stearic acids.

## Saturated fat profile of common foods; Esterified fatty acids as percentage of total fat<sup>[9]</sup>

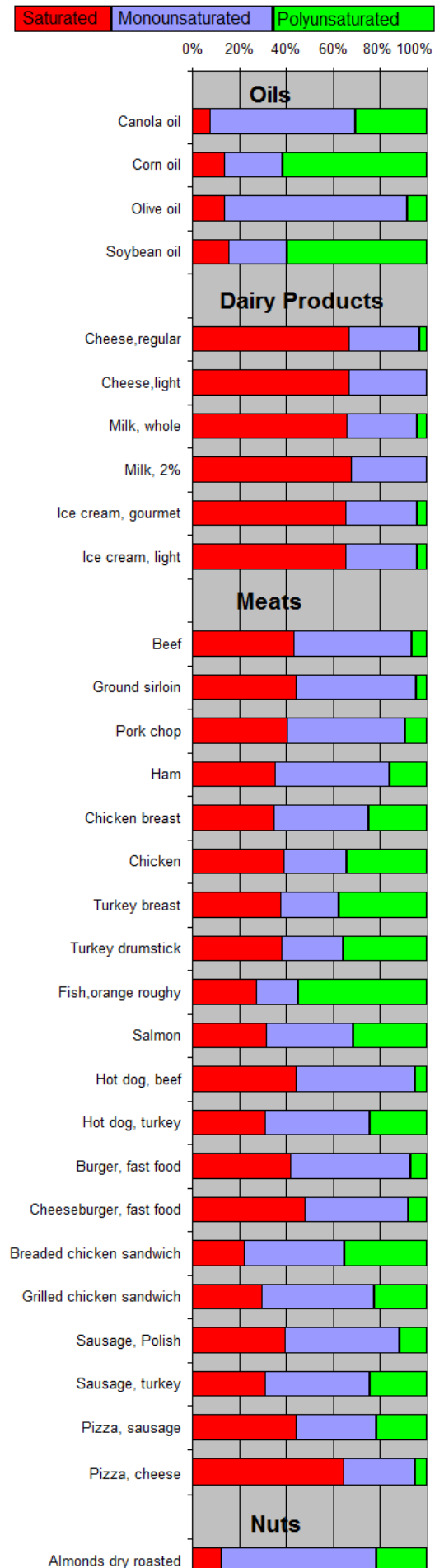
| Food            | Lauric acid | Myristic acid | Palmitic acid | Stearic acid |
|-----------------|-------------|---------------|---------------|--------------|
| Coconut oil     | 47%         | 18%           | 9%            | 3%           |
| Palm kernel oil | 48%         | 1%            | 44%           | 5%           |
| Butter          | 3%          | 11%           | 29%           | 13%          |
| Ground beef     | 0%          | 4%            | 26%           | 15%          |
| Salmon          | 0%          | 1%            | 29%           | 3%           |
| Egg yolks       | 0%          | 0.3%          | 27%           | 10%          |
| Cashews         | 2%          | 1%            | 10%           | 7%           |
| Soybean oil     | 0%          | 0%            | 11%           | 4%           |

## Examples of saturated fatty acids

Some common examples of fatty acids:

- Butyric acid with 4 carbon atoms (contained in butter)
- Lauric acid with 12 carbon atoms (contained in coconut oil, palm kernel oil, and breast milk)
- Myristic acid with 14 carbon atoms (contained in cow's milk and dairy products)
- Palmitic acid with 16 carbon atoms (contained in palm oil and meat)
- Stearic acid with 18 carbon atoms (also contained in meat and cocoa butter)

| Food                          | Saturated                          | Mono-unsaturated | Poly-unsaturated |
|-------------------------------|------------------------------------|------------------|------------------|
|                               | As weight percent (%) of total fat |                  |                  |
| <b>Cooking oils</b>           |                                    |                  |                  |
| Canola oil                    | 8                                  | 64               | 40               |
| Corn oil                      | 13                                 | 24               | 59               |
| Olive oil                     | 7                                  | 78               | 15               |
| Sunflower oil <sup>[17]</sup> | 11                                 | 20               | 69               |
| Soybean oil                   | 15                                 | 24               | 58               |
| Peanut oil <sup>[18]</sup>    | 17                                 | 46               | 32               |
| Rice bran oil                 | 25                                 | 38               | 37               |
| Coconut oil                   | 87                                 | 13               | 1                |
| <b>Dairy products</b>         |                                    |                  |                  |
| Cheese, regular               | 64                                 | 29               | 3                |
| Cheese, light                 | 60                                 | 30               | 0                |
| Milk, whole                   | 62                                 | 28               | 4                |
| Milk, 2%                      | 62                                 | 30               | 0                |
| Ice cream, gourmet            | 62                                 | 29               | 4                |
| Ice cream, light              | 62                                 | 29               | 4                |
| <b>Meats</b>                  |                                    |                  |                  |
| Beef                          | 33                                 | 38               | 5                |
| Ground sirloin                | 38                                 | 44               | 4                |
| Pork chop                     | 35                                 | 44               | 8                |
| Ham                           | 35                                 | 49               | 16               |
| Chicken breast                | 29                                 | 34               | 21               |
| Chicken                       | 34                                 | 23               | 30               |
| Turkey breast                 | 30                                 | 20               | 30               |
| Turkey drumstick              | 32                                 | 22               | 30               |
| Fish, orange roughy           | 23                                 | 15               | 46               |
| Salmon                        | 28                                 | 33               | 28               |
| Hot dog, beef                 | 42                                 | 48               | 5                |
| Hot dog, turkey               | 28                                 | 40               | 22               |
| Burger, fast food             | 36                                 | 44               | 6                |



| Food                          | Saturated                          | Mono-unsaturated | Poly-unsaturated |
|-------------------------------|------------------------------------|------------------|------------------|
|                               | As weight percent (%) of total fat |                  |                  |
| <b>Cooking oils</b>           |                                    |                  |                  |
| Cheeseburger, fast food       | 43                                 | 40               | 7                |
| Breaded chicken sandwich      | 20                                 | 39               | 32               |
| Grilled chicken sandwich      | 26                                 | 42               | 20               |
| Sausage, Polish               | 37                                 | 46               | 11               |
| Sausage, turkey               | 28                                 | 40               | 22               |
| Pizza, sausage                | 41                                 | 32               | 20               |
| Pizza, cheese                 | 60                                 | 28               | 5                |
| <b>Nuts</b>                   |                                    |                  |                  |
| Almonds dry roasted           | 9                                  | 65               | 21               |
| Cashews dry roasted           | 20                                 | 59               | 17               |
| Macadamia dry roasted         | 15                                 | 79               | 2                |
| Peanut dry roasted            | 14                                 | 50               | 31               |
| Pecans dry roasted            | 8                                  | 62               | 25               |
| Flaxseeds, ground             | 8                                  | 23               | 65               |
| Sesame seeds                  | 14                                 | 38               | 44               |
| Soybeans                      | 14                                 | 22               | 57               |
| Sunflower seeds               | 11                                 | 19               | 66               |
| Walnuts dry roasted           | 9                                  | 23               | 63               |
| <b>Sweets and baked goods</b> |                                    |                  |                  |
| Candy, chocolate bar          | 59                                 | 33               | 3                |
| Candy, fruit chews            | 14                                 | 44               | 38               |

| Food   | Saturated                          | Mono-unsaturated | Poly-unsaturated |
|--|------------------------------------|------------------|------------------|
|  | As weight percent (%) of total fat |                  |                  |
| <b>Cooking oils</b>  |                                    |                  |                  |
| Cookie, oatmeal raisin   | 22                                 | 47               | 27               |
| Cookie, chocolate chip   | 35                                 | 42               | 18               |
| Cake, yellow   | 60                                 | 25               | 10               |
| Pastry, Danish   | 50                                 | 31               | 14               |
| <b>Fats added during cooking or at the table</b>                   |                                    |                  |                  |
| Butter, stick  | 63                                 | 29               | 3                |
| Butter, whipped  | 62                                 | 29               | 4                |
| Margarine, stick   | 18                                 | 39               | 39               |
| Margarine, tub   | 16                                 | 33               | 49               |
| Margarine, light tub   | 19                                 | 46               | 33               |
| Lard   | 39                                 | 45               | 11               |
| Shortening   | 25                                 | 45               | 26               |
| Chicken fat  | 30                                 | 45               | 21               |
| Beef fat   | 41                                 | 43               | 3                |
| Dressing, blue cheese  | 16                                 | 54               | 25               |
| Dressing, light Italian  | 14                                 | 24               | 58               |
| <b>Other</b>   |                                    |                  |                  |
| Egg yolk fat <sup>[19]</sup>                                       | 36                                 | 44               | 16               |
| Avocado <sup>[20]</sup>  | 16                                 | 71               | 13               |
| Unless else specified in boxes, then reference is: <sup>[21]</sup> |                                    |                  |                  |

## Association with diseases

Since the 1950s, it has been commonly believed that consumption of foods containing high amounts of saturated fatty acids (including meat fats, milk fat, butter, lard, coconut oil, palm oil, and palm kernel oil) is potentially less healthy than consuming fats with a lower proportion of saturated fatty acids. Sources of lower saturated fat but higher proportions of unsaturated fatty acids include olive oil, peanut oil, canola oil, avocados, safflower, corn, sunflower, soy, and cottonseed oils.<sup>[22]</sup>

## Cardiovascular disease

The effect of saturated fat on cardiovascular disease is controversial.

Many health authorities such as the American Dietetic Association,<sup>[23]</sup> the British Dietetic Association,<sup>[24]</sup> American Heart Association,<sup>[25]</sup> the World Heart Federation,<sup>[26]</sup> the British National Health Service,<sup>[27]</sup> among others,<sup>[28][29]</sup> advise that saturated fat is a risk factor for cardiovascular disease. The World Health Organization in May 2015 recommends switching from saturated to unsaturated fats.<sup>[30]</sup>

A number of systematic reviews have examined the relationship between saturated fat and cardiovascular disease and have come to different conclusions:

A 2015 systematic review found no association between consumption and risk of heart disease, stroke, diabetes, or death.<sup>[31]</sup>

A 2014 systematic review looking at observational studies of dietary intake of fatty acids, observational studies of measured fatty acid levels in the blood, and intervention studies of polyunsaturated fat supplementation concludes that the findings "do not support cardiovascular guidelines that promote high consumption of long-chain omega-3 and omega-6 and polyunsaturated fatty acids and suggest reduced consumption of total saturated fatty acids."<sup>[32]</sup> Researchers acknowledged that despite their results, further research is necessary, especially in people who are initially healthy. Until the picture becomes clearer, experts recommend people stick to the current guidelines on fat consumption.<sup>[33]</sup>

|                                   |   |
|-----------------------------------|---|
| Harcombe, 2015 <sup>[34]</sup>    | No reduction in CHD and all-cause mortality were observed when replacing saturated fat with polyunsaturated fat, even though reductions in serum cholesterol were observed.   |
| Schwab, 2014 <sup>[35]</sup>      | There was convincing evidence that partial replacement of saturated fat with polyunsaturated fat decreases the risk of cardiovascular diseases, especially in men.  |
| Hooper, 2011 <sup>[36]</sup>      | Reducing saturated fat in diets did not reduce mortality, despite reducing the risk of having a cardiovascular event by 14 percent.   |
| Micha, 2010 <sup>[37]</sup>       | Based on consistent evidence from human studies, replacing saturated fatty acids with polyunsaturated fat modestly lowers coronary heart disease risk, with ~10% risk reduction for a 5% energy substitution; whereas replacing SFA with carbohydrate has no benefit and replacing SFA with monounsaturated fat has uncertain effects.  |
| Mozaffarian, 2010 <sup>[38]</sup> | These findings provide evidence that consuming polyunsaturated fats (PUFA) in place of SFA reduces Coronary Heart Disease (CHD) events in randomized controlled trials (RCT). Replacing saturated fats with PUFAs as percentage of calories strongly reduced CHD mortality.   |
| Siri-Tarino, 2010 <sup>[39]</sup> | 5–23 years of follow-up of 347,747 subjects, 11,006 developed CHD or stroke. A meta-analysis of prospective epidemiologic studies showed that there is no significant evidence for concluding that dietary saturated fat is associated with an increased risk of CHD or CVD.  |
| Danaei, 2009 <sup>[40]</sup>      | Low PUFA intake has an 1-5% Increased risk of ischemic heart disease: Low dietary PUFA (in replacement of SFA). age 30–44 Increase in RR 1.05.  |
| Mente, 2009 <sup>[41]</sup>       | Single-nutrient RCTs have yet to evaluate whether reducing saturated fatty acid intake lowers the risk of CHD events. For polyunsaturated fatty acid intake, most of the RCTs have not been adequately powered and did not find a significant reduction in CHD outcomes.  |
| Skeaff, 2009 <sup>[42]</sup>      | Intake of SFA was not significantly associated with CHD mortality, with a RR of 1.14. Moreover, there was no significant association with CHD death. Intake of PUFA was strongly significantly associated with CHD mortality, with a RR of 1.25. The Health Professionals Follow-up Study and the EUROASPIRE study results mirrored those of total PUFA; intake of linoleic acid was significantly associated with CHD mortality. |
| Jakobsen, 2009 <sup>[43]</sup>    | "The associations suggest that replacing saturated fatty acids with polyunsaturated fatty acids rather than monounsaturated fatty acids or carbohydrates prevents CHD over a wide range of intakes."  |
| Van Horn, 2008 <sup>[44]</sup>    | 25-35% fats but <7% SFA and TFA reduces risk.   |

While many studies have found that including polyunsaturated fats in the diet in place of saturated fats produces more beneficial CVD outcomes, the effects of substituting monounsaturated fats or carbohydrates are unclear.<sup>[45][46]</sup>

## Dyslipidemia

The consumption of saturated fat is generally considered a risk factor for dyslipidemia, which in turn is a risk factor for some types of cardiovascular disease.<sup>[47][48][49][50][51]</sup>

There are strong, consistent, and graded relationships between saturated fat intake, blood cholesterol levels, and the mass occurrence of cardiovascular disease. The relationships are accepted as causal.<sup>[52][53]</sup> Abnormal blood lipid levels, that is high total cholesterol, high levels of triglycerides, high levels of low-density lipoprotein (LDL, "bad" cholesterol) or low levels of high-density lipoprotein (HDL, "good" cholesterol) cholesterol are all associated with increased risk of heart disease and stroke.<sup>[26]</sup>

Meta-analyses have found a significant relationship between saturated fat and serum cholesterol levels.<sup>[54]</sup> High total cholesterol levels, which may be caused by many factors, are associated with an increased risk of cardiovascular disease.<sup>[55][56]</sup> However, other indicators measuring cholesterol such as high total/HDL cholesterol ratio are more predictive than total serum cholesterol.<sup>[56]</sup> In a study of myocardial infarction in 52 countries, the ApoB/ApoA1 (related to LDL and HDL, respectively) ratio was the strongest predictor of CVD among all risk factors.<sup>[57]</sup> There are other pathways involving obesity, triglyceride levels, insulin sensitivity, endothelial function, and thrombogenicity, among others, that play a role in CVD, although it seems, in the absence of an adverse blood lipid profile, the other known risk factors have only a weak atherogenic effect.<sup>[58]</sup> Different saturated fatty acids have differing effects on various lipid levels.<sup>[59]</sup>

## Cancer

### Breast cancer

A meta-analysis published in 2003 found a significant positive relationship in both control and cohort studies between saturated fat and breast cancer.<sup>[60]</sup> However two subsequent reviews have found weak or insignificant associations of saturated fat intake and breast cancer risk,<sup>[61][62]</sup> and note the prevalence of confounding factors.<sup>[61][63]</sup>

### Colorectal cancer

One review found limited evidence for a positive relationship between consuming animal fat and incidence of colorectal cancer.<sup>[64]</sup>

### Ovarian cancer

A meta-analysis of eight observational studies published in 2001 found a statistically significant positive relationship between saturated fat and ovarian cancer.<sup>[65]</sup> However, a 2013 study found that a pooled analysis of 12 cohort studies observed no association between total fat intake and ovarian cancer risk. Further analysis revealed that omega-3 fatty acids were protective against ovarian cancer and that trans fats were a risk factor.<sup>[66]</sup> This study revealed that histological subtypes should be examined in determining the impact of dietary fat on ovarian cancer, rather than an oversimplified focus on total fat intake.

### Prostate cancer

Some researchers have indicated that serum myristic acid<sup>[67][68]</sup> and palmitic acid<sup>[68]</sup> and dietary myristic<sup>[69]</sup> and palmitic<sup>[69]</sup> saturated fatty acids and serum palmitic combined with alpha-tocopherol supplementation<sup>[67]</sup> are associated with increased risk of prostate cancer in a dose-dependent manner. These associations may, however, reflect differences in intake or metabolism of these fatty acids between the precancer cases and controls, rather than being an actual cause.<sup>[68]</sup>



## Bones

Mounting evidence indicates that the amount and type of fat in the diet can have important effects on bone health. Most of this evidence is derived from animal studies. The data from one study indicated that bone mineral density is negatively associated with saturated fat intake, and that men may be particularly vulnerable.<sup>[70]</sup>

## Dietary recommendations

Recommendations to reduce or limit dietary intake of saturated fats are made by the World Health Organization,<sup>[71]</sup> Health Canada,<sup>[72]</sup> the US Department of Health and Human Services,<sup>[73]</sup> the UK Food Standards Agency,<sup>[74]</sup> the Australian Department of Health and Aging,<sup>[75]</sup> the Singapore Government Health Promotion Board,<sup>[76]</sup> the Indian Government Citizens Health Portal,<sup>[77]</sup> the New Zealand Ministry of Health,<sup>[78]</sup> the Food and Drugs Board Ghana,<sup>[79]</sup> the Republic of Guyana Ministry of Health,<sup>[80]</sup> and Hong Kong's Centre for Food Safety.<sup>[81]</sup>

In 2003, the World Health Organization (WHO) and Food and Agriculture Organization (FAO) expert consultation report concluded that "intake of saturated fatty acids is directly related to cardiovascular risk. The traditional target is to restrict the intake of saturated fatty acids to less than 10% of daily energy intake and less than 7% for high-risk groups. If populations are consuming less than 10%, they should not increase that level of intake. Within these limits, intake of foods rich in myristic and palmitic acids should be replaced by fats with a lower content of these particular fatty acids. In developing countries, however, where energy intake for some population groups may be inadequate, energy expenditure is high and body fat stores are low (BMI <18.5 kg/m<sup>2</sup>). The amount and quality of fat supply has to be considered keeping in mind the need to meet energy requirements. Specific sources of saturated fat, such as coconut and palm oil, provide low-cost energy and may be an important source of energy for the poor."<sup>[82]</sup>

A 2004 statement released by the Centers for Disease Control (CDC) determined that "Americans need to continue working to reduce saturated fat intake..."<sup>[83]</sup> In addition, reviews by the American Heart Association led the Association to recommend reducing saturated fat intake to less than 7% of total calories according to its 2006 recommendations.<sup>[84][85]</sup> This concurs with similar conclusions made by the US Department of Health and Human Services, which determined that reduction in saturated fat consumption would positively affect health and reduce the prevalence of heart disease.<sup>[86]</sup>

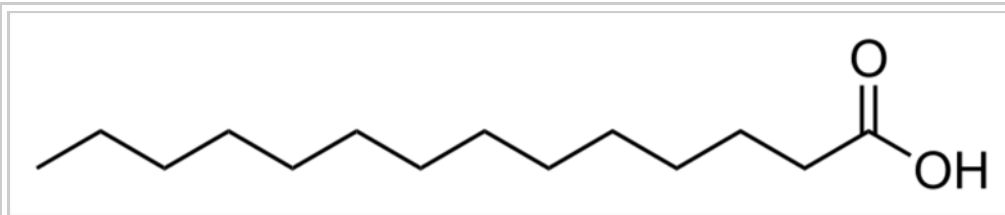
The United Kingdom, National Health Service claims the majority of UK people eat too much saturated fat. The British Heart Foundation also advises people to cut down on saturated fat. People are advised to cut down on saturated fat and read labels on food they buy.<sup>[87][88]</sup>

Dr. German and Dr. Dillard of University of California and Nestle Research Center in Switzerland, in their 2004 review, pointed out that "no lower safe limit of specific saturated fatty acid intakes has been identified" and recommended that the influence of varying saturated fatty acid intakes against a background of different individual lifestyles and genetic backgrounds should be the focus in future studies.<sup>[89]</sup>

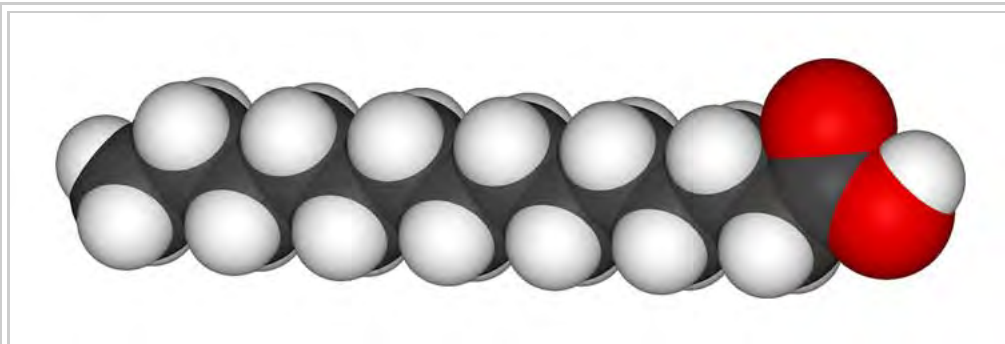
Blanket recommendations to lower saturated fat were criticized at a 2010 conference debate of the American Dietetic Association for focusing too narrowly on reducing saturated fats rather than emphasizing increased consumption of healthy fats and unrefined carbohydrates. Concern was expressed over the health risks of replacing saturated fats in the diet with refined carbohydrates, which carry a high risk of obesity and heart disease, particularly at the expense of polyunsaturated fats which may have health benefits. None of the

panelists recommended heavy consumption of saturated fats, emphasizing instead the importance of overall dietary quality to cardiovascular health.<sup>[90]</sup>

## Molecular description



Two-dimensional representation of the saturated fatty acid myristic acid



A space-filling model of the saturated fatty acid myristic acid

It should be noted, as this is the defining factor of **saturated** fats, that the two-dimensional illustration has implicit hydrogen atoms bonded to each of the carbon atoms in the polycarbon tail of the myristic acid molecule (there are 13 carbon atoms in the tail; 14 carbon atoms in the entire molecule).

Carbon atoms are also implicitly drawn, as they are portrayed as intersections between two straight lines. "Saturated," in general, refers to a maximum number of hydrogen atoms bonded to

each carbon of the polycarbon tail as allowed by the Octet Rule. This also means that only single bonds (sigma bonds) will be present between adjacent carbon atoms of the tail.









## See also




- List of saturated fatty acids
- List of vegetable oils
- Trans fat
- Food groups
- Food guide pyramid
- Healthy diet
- Diet and heart disease
- Fast food
- Junk food
- Advanced glycation endproduct
- ANGPTL4
- Iodine value
- Framingham Heart Study
- Seven Countries Study
- Ancel Keys
- D. Mark Hegsted

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