

The nutritional necessity of fat



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Nutritional necessity of fat

- **Fat is an essential part of a healthy, well balanced diet:**
 - Provides essential fatty acids
 - Provides and facilitates the absorption of the fat-soluble vitamins A, D, E and K
 - It improves the taste and texture of food
 - Important source of food energy

Essential fatty acids

- **Cannot be made in the body but are essential for normal physiological functioning:**
 - Needed to support normal growth
 - Immune function
 - Maintenance of healthy skin
 - Vision, memory & learning
 - Eicosanoid precursors - 'pharmacological' properties

Fat & Vitamins

- **Fat supplies and facilitates the absorption of fat soluble vitamins (A, D, E & K)**
- **Vitamin E; Vegetable oils are the major dietary source**

Vitamin E is important for: maintaining healthy skin,
antioxidant; heart and circulation

- **Vitamin K is found in high amounts in some vegetable oils, e.g. corn oil**

Vitamin K is important for: blood clotting
health of bones and skin

Other reasons for fat in the diet

- **Flavour** - acts as a solvent for flavours and thereby improves the taste of foods
- **Texture** - the physical structure of fat particles impart a creamy texture to foods improving their palatability
- **Structural lipids** (mainly from phospholipids and cholesterol) are important in cellular membranes
- **Added benefit in a mixed meal; it slows gastric emptying - so reduces glycaemic load of a meal**

Other reasons for fat in the diet

- To be 'healthy' we need % body fat:
 - Men; 12-15%
 - Women; 18-25%
- Protects and cushions delicate organs
- Important energy reserve during pregnancy and lactation

Fat as an energy source

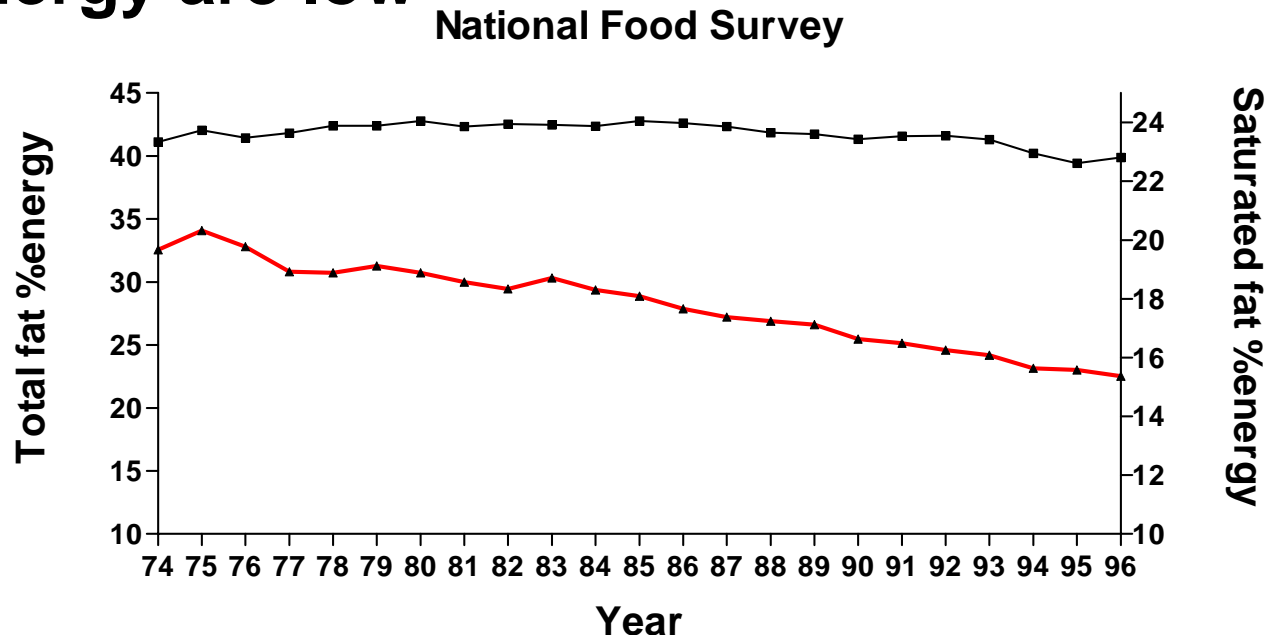
- **Fat is a concentrated source of calories:**
 - it provides 9 kcal/g (37kJ/g) compared with ~4 kcal/g for protein (18kJ/g) and carbohydrate (17kJ/g)
- **% energy from fat = fat in g x 9 x 100 / total energy intake in kcal**
- **The higher % energy from fat the more energy-dense the diet:**
 - Breast milk 52%
 - Asian and African rural diet 10-15%
 - Japanese diet 25-30%
 - European and American diet 35-42%

Fat and obesity

- **Excess food energy is stored as fat regardless of the source**
- **Body fat accumulates when energy expenditure is lower than energy intake**
- **Obesity has increased from 5% to >20% of the adult population in the UK since the mid-1980s**
- **Why is this??**
 - Is it due to a high fat intake or increased calorie intake?
 - Is it due to 'super-sizing'?

Fat and obesity

- Decreased physical activity is probably the main reason for the increased prevalence of obesity
- Fat intake (g/d) has reduced and our proportion of energy derived from fat has remained stable
- But.... It may be easier to maintain energy balance on a lower % energy from fat where requirements for energy are low



Types of fat

What is fat?

- **Fat is made up of fatty acids and their esters**
- **The most common fats/lipids are:**
 - Triacylglycerols (TAG)
 - Phospholipids
 - Cholesterol esters
- **Dietary fat consists mainly of triacylglycerols (90-98%)**
- **TAG used for energy storage in adipose tissue**

TAGs & fatty acids

- TAG are made up of 3 fatty acids and 1 glycerol molecule
- The mixture of fatty acids within the TAG determines the properties of the TAG, which in turn determines the properties of the dietary fat mixture
- They differ in:
 - chain length (no. of carbons)
 - unsaturation (no. of double bonds)
 - position and geometry (*cis* or *trans*) of double bonds

→ determine their melting properties, degree of saturation and health effects

Fatty acids

Fatty acids are classed as:

- **Saturated Fatty Acids (SFAs)**
- **Unsaturated Fatty Acids**
 - Monounsaturated Fatty Acids (MUFAs)
 - Polyunsaturated Fatty Acids (PUFAs); Essential Fatty Acids (EFAs)
 - *Trans*
- **The mixture of SFAs, MUFAs and PUFAs within the dietary fat determine its qualities**

Saturated fatty acids

- **No double bonds, commonly 12-18 carbons long, solid at room temperature, animal origin**
 - Palmitic acid (palm oil), Stearic acid (dairy products), Myristic acid (butter)
- **Often called ‘bad’ fat - raise total cholesterol by increasing ‘bad’ cholesterol (LDL) → increase risk of CHD**
- **Current UK intakes of SFAs are 13% energy; recommended amounts are <11% energy**
- **Main dietary sources in UK include:**

Full-fat dairy food, butter, meat and meat products (pastries), biscuits, cakes.

Unsaturated fatty acids

- **Contain 1 or more double bonds**
- **Monounsaturated fatty acid**
 - 1 double bond
- **Polyunsaturated fatty acids**
 - 2 or more double bonds
 - Essential fatty acids; omega / n-3 and omega / n-6 series
- **Commonly 16-22 carbon atoms long**
- **Double bonds can exist in 2 forms: *cis* or *trans***
- **Most common form is '*cis*'**

Cis vs. Trans fatty acids

- ***Trans* formed by ruminants (cows, sheep) by bacterial fermentation and during partial hydrogenation of fats (used by food industry to harden fats)**
- ***Cis* – both hydrogen atoms are on the same side on the double bond (kink) – lowers the melting points**
- ***Trans* – hydrogen atoms are on opposite sides of carbon chain (straight) – higher melting point than *cis* (behaves in a similar way to a SFA)**
- **TFAs increase LDL ‘bad’ cholesterol and reduce HDL ‘good’ cholesterol → increase risk of CHD**

Trans fatty acids

- **No more than 2% of our daily calorie intake should be from TFAs; current UK intakes are 1%**
- **Margarine is often quoted as a source of TFAs, but:**
 - there are no margarine brands on sale in the UK any more; margarines were classified as being made up of 80-90% fat
 - instead, there is a wide range of vegetable oil spreads - all brands of spreads on sale in the UK are virtually *trans-free*
- **Main dietary sources in UK include:**

Biscuits, cakes, cheese, meat pies & pastries

Cis - Monounsaturated fat

- **Oleic acid is the main MUFA in our diet (sometimes referred to as an omega 9 or n-9 fatty acid)**
- **Rich sources of oleic acid:**

olive and rapeseed oils, spreads made from these, meat, nuts and seeds

- **Reduces LDL cholesterol - 'Mediterranean diet'**
- **Current UK intakes of MUFAs are 12% energy; recommended amounts are 13% energy**
- **Main dietary sources in UK include:**

meat and meat products, cereals, potato snacks and spreads

Polyunsaturated fat

- **Two different ‘families’ of polyunsaturated fatty acids**
 - Omega 6 / n-6
 - Omega 3 / n-3
- **The position of the first double-bond relative to the omega end determines whether a PUFA is n-3 or n-6**
- **They are also known as essential fatty acids, because the body cannot make them but are essential to normal physiological functioning**
- **PUFA can lower LDL cholesterol & triacylglycerol**

Omega 6 / n-6 fatty acids

- **n-6 fatty acids aid growth, reproduction, haemostasis, immune function and healthy skin**
- **Current UK intakes of n-6 are 5% energy; recommended intakes are 6% energy**
- **Dietary sources include:**

vegetable oils such as sunflower, safflower, corn and soya oils, fat spreads made from these, meats, nuts and seeds

Omega 3 / n-3 fatty acids

- **n-3 aids vision, memory and learning and cardiac function – protection from arrhythmias**
- **Current UK intakes of n-3 are 1%; recommended amounts are >0.2%**
- **However....**
 - the ratio of n-6/n-3 is important
 - many of the health benefits come from the very long chain n-3 (found in fish) rather than long chain n-3 (found in plant oils)
 - the level of very long chain n-3 intake needs to be increased

Omega 3 / n-3 fatty acids

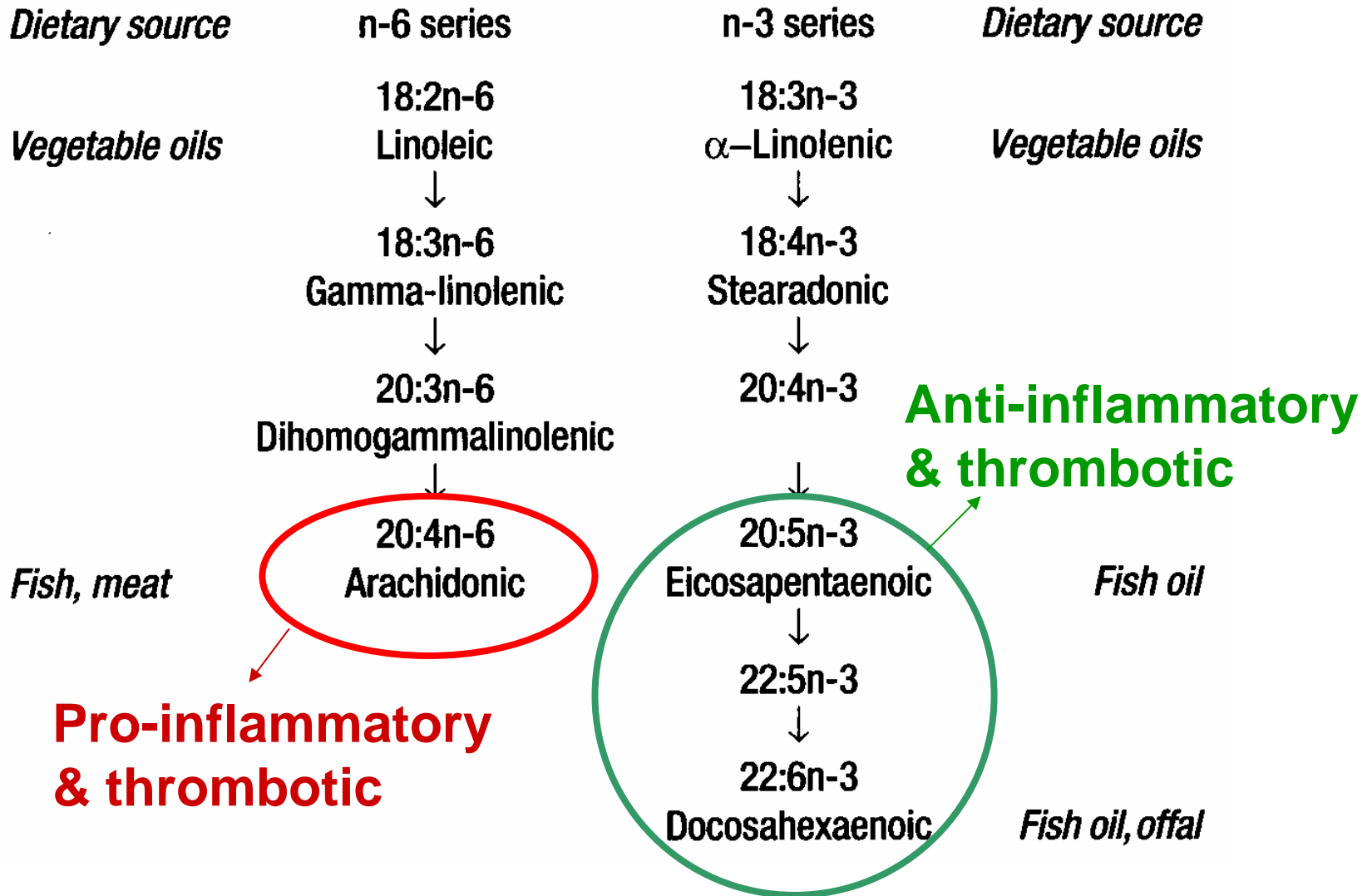
- **Rich sources of n-3:**

oil-rich fish (sardines, mackerel, salmon) and spreads

- **Main dietary sources in UK include:**

cereal products, meat products, fish and chips

Polunsaturated fat



Ratio of n-6 : n-3 is very important

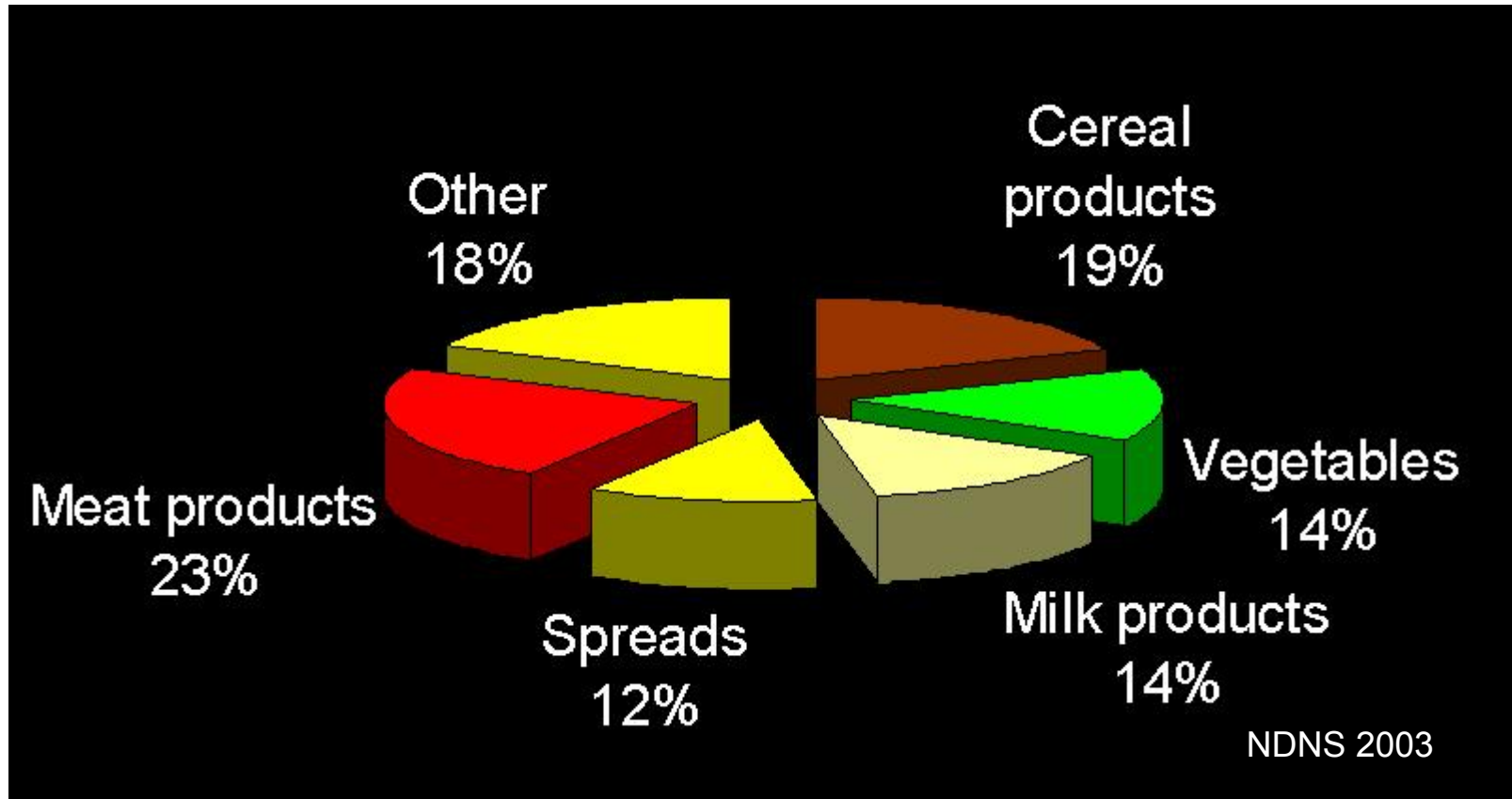
Polyunsaturated fat

- **The current British diet provides n-6 and n-3 in a ratio of 7:1, this has increased since**
 - 1950s (4:1)
 - Stone Age Man (believed to be 1.5:1)
 - Intake of n-6 in the diet has almost doubled as a result of the popularity of vegetable oils and spreads
- **The recommended ratio of n-6/n-3 is between 5:1 and 10:1**
- **Studies have shown that 4:1 maximises health benefits**
- **We need to ensure an adequate intake of n-3 fatty acids**

Omega-3 fatty acids

- **Good sources:**
 - **Very long chain n-3**; eicosapentaenoic acid (EPA) decosahexaenoic acid (DHA) - **Fish**
 - **Long chain n-3**; α linolenic acid (ALA) - **Plant oils and spreads**
- **The very long chain n-3 fatty acids are responsible for their 'pharmacological' actions, i.e. anti-inflammatory & thrombotic**
- **There is approximately 10% conversion of long chain n-3 to very long chain n-3**

Contribution of food groups to total fat in the diet of British adults



Fats & disease prevention

Fats & disease prevention

	Decreased risk	No relationship	Increased risk
CVD			
Convincing	EPA/DHA; LA		C14, 16 SFA
Probable	ALNA; oleic acid	Stearic acid	
Possible			C12 SFA
Type 2 diabetes			
Probable			SFA
Possible	n-3		Total fat
Cancer			
Possible	n-3		Animal fats

Fats & CHD

- **Cardiovascular disease is the leading cause of mortality worldwide**
- **The *type* of fat rather than total fat intake is related to risk of CHD**
- **Lowering blood cholesterol levels significantly reduces the incidence of CHD:**
 - SFAs (lauric, myristic and palmitic) and TFAs raise total and LDL cholesterol (stearic acid is neutral)
 - Compared with SFAs:
 - MUFAs: ↓ LDL, = HDL, ↓ Total/HDL
 - PUFAs: ↓↓ LDL, = HDL, ↓↓ Total/HDL
 - TRANS: ↑ LDL, ↓ HDL, ↑↑ Total/HDL

Total/HDL chol ratio is strongest predictor of CHD risk

Fats vs. carbohydrates & CHD

- Replacing fat with carbohydrates (CHO):
 - decreases HDL (good) cholesterol and raises triacylglycerol (TAG) levels in the blood
- Compared with CHO:
 - SFAs: ↑ LDL, ↓ TAG, ↑ HDL, = Total/HDL
 - MUFAs: ↓ LDL & TAG, ↑ HDL, ↓ Total/HDL
 - PUFAs: ↓↓ LDL & TAG, ↑ HDL, ↓↓ Total/HDL
 - TRANS: ↑↑ LDL, ↓ TAG, = HDL, ↑↑ Total/HDL

Does the beneficial effect of replacing CHO with fat on blood lipids outweigh potential adverse effects of body weight increases (3kg)?

Fats & other diseases

Diabetes

- Fatty acids affect different metabolic pathways, including those involved with glycaemic control
 - People with diabetes should consume a low SFA diet because of the risk of developing CVD
 - High-MUFA diets are associated with improvements in glycaemic control – a low fat (21% energy from fat) and a high MUFA diet (35% energy from fat) appear to afford similar glycaemic control
 - » However diabetics must maintain a healthy body weight

Fats & other diseases

Cancer

- Approximately, 30% of all human cancers may be influenced by diet, lifestyle and physical activity
 - Unsaturated fatty acids, namely n-3 and MUFAs may be associated with a reduced risk of developing certain cancers, including cancer of the colon, breast and prostate
 - However, more evidence is needed

Fats & other diseases

Inflammatory conditions

- Inflammatory conditions, such as asthma, Crohn's disease and arthritis can be improved by the anti-inflammatory actions of n-3 fatty acids

Cognitive function and behaviour

- **Brain cells are especially rich in DHA**
 - dietary status of these fatty acids might influence cognitive function and behaviour (such as depression)
 - However, more evidence is needed

Current & recommended intakes

	UK DRV	Current intakes		
		% EI	Men	Women
			g/day	g/day
Total fat	<35	35	86.5	61.4
SFA	<11	13	32.5	23.3
MUFA (<i>cis</i>)	13	12	29.1	20.2
PUFA	6.5	6	15	11
n-6 PUFA	>1	5	13	9.4
n-3 PUFA	>0.2	1	2.3	1.7
MUFA (<i>trans</i>)	<2	1.2	2.91	2.04

More than 70% of UK population consume more than 11% energy from SFA

% EI - % energy intake

UK DRV – Daily recommended value (COMA)