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Fat overloading as a cause of degenerative disease in man**

Summary. *The present fat intake in the Netherlands amounts to 85 to 125 g/day, or 40% of energy. Historically this is high. Our paleolithic ancestors may have consumed a lot of meat, but their intake of fat, especially of saturated fat, was probably low, because in contrast to modern farm animals, wild animals contain little saturated fat. Low fat intakes were the rule in the Netherlands throughout the first half of this century, possibly because dietary fat was expensive. Agricultural science and food technology, however, have now made fat the cheapest source of energy. The increased consumption of saturated fat is probably one of the causes of the increase in ischaemic heart disease since 1950. Recently a new dietary trend is emerging in the United States of America: total fat intake remains stable, but the consumption of unsaturated fatty acids increases at the expense of saturated fatty acids. Evaluation of the health effects of this trend requires careful monitoring of intakes. Analysis of subcutaneous fat tissue biopsies is a suitable technique for this.*

Introduction

The question to be addressed in this paper is whether the present fat intake in our society is excessive and causes disease, with emphasis on ischaemic heart disease.

Fat intake in The Netherlands amounts to 40% of dietary energy, or some 85 to 125 gram per day. Similar figures are found for all affluent populations, even though they eat widely different foods. This amount is clearly excessive for patients with certain genetic or acquired metabolic disturbances. Thus the patient with type I hyperlipoproteinaemia gets massive hypertriglyceridaemia plus its various complications when he eats 100 g of fat per day, or even much less. The reason for this is that he lacks the lipoprotein lipase enzyme that is present in the blood vessels of normal persons and breaks down the fat provided by the diet. Other diseases exist in which fat is also poorly tolerated. But is our present fat intake excessive for normal people?

Fat intakes in the past

To illuminate this question, let us look at the 'natural' diet of our paleolithic ancestors. We do not know for certain what they were eating, but Eaton and Konner have made an educated guess (table 1) (1). They think that our ancestors ate

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Table 1. Late paleolithic* and current diet in the United States of America (modified from ref. 1).

	paleolithic	current
	(% of dietary energy)	
protein	34	12
carbohydrate	45	46
fat	21	42
P/S-ratio	1.4	0.4

* Assuming 35% meat, 65% vegetables.

Table 2. Fat content and fatty acid composition of wild and farm animals.

source	lipid content (g/100)	polyunsaturated/ saturated fatty acids
kangaroo	1.5	(1.1)
wild buffalo	3	0.8
'wild' mackerel*	17	0.8
Dutch beef	5-21	0.1
pork	24	0.2

* This is mackerel caught in the open sea. If mackerel were to be produced by fish farming then the P/S-ratio of the body fat might become lower.

21% of energy as fat, a large part of it polyunsaturated. In spite of this low fat intake, they still consumed large amounts of meat, which provided 35% of their daily energy. Table 2 shows how this is possible. The meat of 'natural' wild animals is much lower in fat, especially in saturated fatty acids, than that of modern farm animals.

How about the more recent past? As shown in table 3, at the start of this century even affluent people like doctors were eating a fairly lean diet. The present level of fat intake was reached only around 1960, and it presents a unique, new situation. Obviously, many people like to eat fat or fat-rich foods, and they eat low-fat diets only as long as they cannot afford to buy fat-rich products. Many proverbs attest to the fact that a lack of dietary fat is considered one of the hardships of poverty.

Production and properties of fat

Agricultural science and food technology have made fat cheap and abundant, to the point where fat has become cheaper per unit of energy than common carbohydrate sources such as bread and potatoes. Thanks to this, one can provide all food

Table 3. Former and present fat intakes in The Netherlands (modified after ref. 3).

year	category	fat intake (en%)
1900	doctors	32
1907	labourers	17
1910	fishermen	26
1932	prisoners	13
1963	prisoners	31
1963-1968	various groups	37-45

Table 4. What does energy cost?

	Price per 10 MJ*
sugar	Hfl. 1,40
potatoes	Hfl. 0,89
bread	Hfl. 2,64
cheap brick margarine	Hfl. 0,58
butter	Hfl. 3,63

* 10 Megajoule = 2400 Kcal

energy needed by a family of four for as little as Hfl.70,– per month (table 4). Of course it takes more to survive than just energy, but edible fat is no longer an expensive commodity.

Although vegetable fat sources such as soybean oil provide an important proportion of our daily fat intake, fats produced by farm animals also have a large share, in the form of meat, milk, butter and cheese. This brings us to the composition of dietary fats. Are there differences, and do they matter?

Table 5 shows that there are indeed large differences in fatty acid composition between dietary fats. The first line in table 5 gives the composition of an animal fat, butter. Butter is unique in being very high in saturated fatty acids and cholesterol, and in containing almost no *cis-cic* linoleic acid. This is brought about by the bacteria in the rumen of the cow. In the absence of oxygen these bacteria hydrogenate the unsaturated fatty

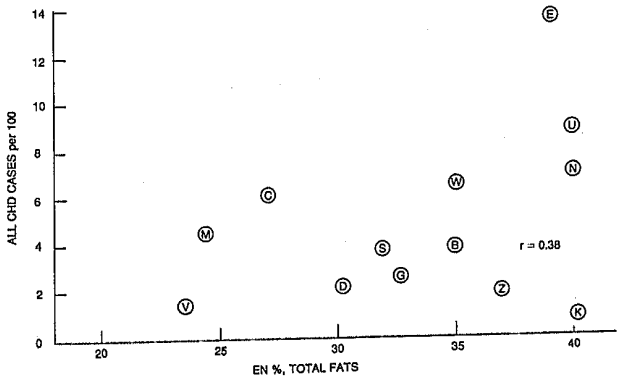

Figure 1. Relation between total fat intake and incidence of coronary heart disease (CHD) in the next five years in groups of middle-aged men from seven countries. Each letter denotes the mean of one cohort (from ref. 7).

Table 5. Fatty acids and cholesterol in butter and margarines (from ref. 5).

type	saturated fatty acids	*trans*-unsaturated fatty acids	*cis-cis*-linoleic acid	cholesterol
	g/100 g of product			mg/10 g
butter	50	6	1	220
brick margarine with animal fat	26	30	10	140
'dieet' margarine	18	1-2	48	0

acids that are present in the cow's feed, and these rumen bacteria are also responsible for the *trans*-unsaturated fatty acids found in butter.

The fatty acids synthesized and stored by the animal itself are also largely saturated. The main function of the large mass of fat found in the body of the modern farm animal is to serve as a fuel reserve, and any effort spent by the cells of the animal on desaturation of these storage fatty acids would be a waste of metabolic energy.

The second entry in table 5 is a mixed animal/vegetable margarine, the animal fat being provided by hardened fish oils. The margarine industry mostly uses plant fats as raw material, because they can be produced cheaply. Most plants store their excess energy as carbohydrates. This is logical: unlike animals, plants do not need to carry their spare fuel around, and the heat-isolating and cushioning effects that make subcutaneous fat useful for animals have no value for plants. Only a small number of plants contains enough fat to be economically interesting, and much of this fat is unsaturated. Although certain economically important plants do produce highly saturated fats (e.g. palm fat, palm kernel fat and coconut fat), much of what goes into margarines is liquid (e.g. soybean and sunflower oil). Originally, the margarine industry hydrogenated these oils, in an effort to produce a hard product similar to butter. The brick margarine described in table 5 is typical. It is somewhat lower in saturated fatty acids than butter, but that is made up for by *trans*-unsaturated fatty acids. However, in the last 20 years soft margarines have become popular, and these have a fatty composition closer to that of the oils from which they are produced. The 'dieet' margarine in table 5 is typical.

Fat intake and heart disease

In populations with a high fat intake, coronary heart disease is usually more prevalent, but the relation between total fat intake and heart disease is not very strong, as shown in figure 1 for the Seven Countries Study.

The reason for this probably is that in the Seven Countries Study the populations with a high fat intake had marked differences in the fatty acid composition of the diet. Thus, the men from Crete (K in figure 1) consumed a lot of olive oil, and the men from East Finland (E) a lot of dairy fat. If only the saturated fatty acids in the diet are plotted then the relation with subsequent coronary heart disease mortality is much stronger (figure 2).

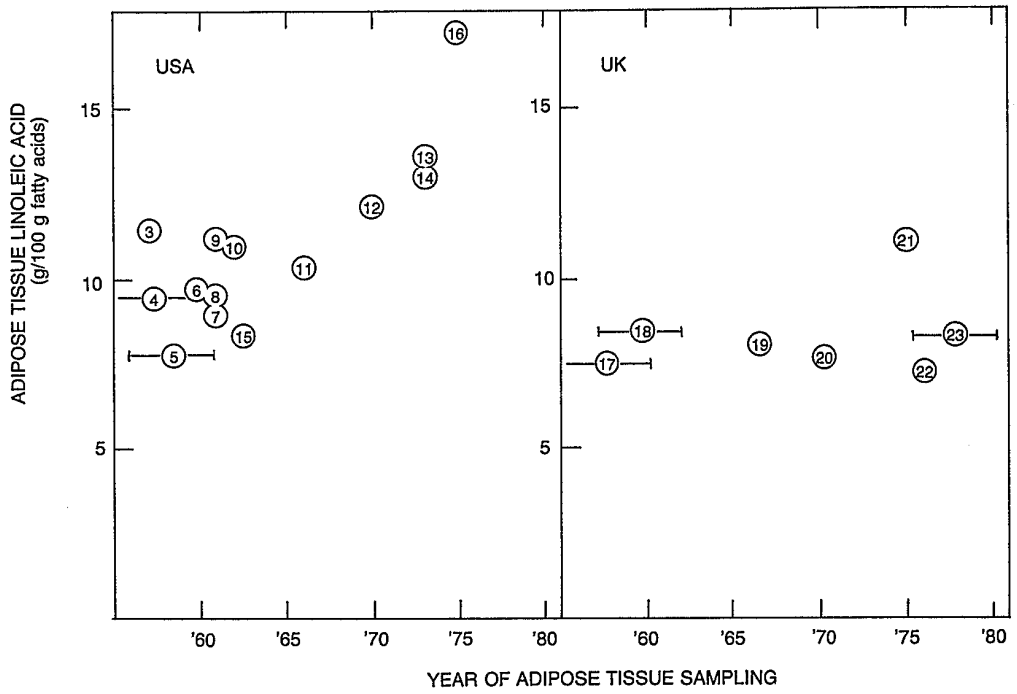

Figure 2. Relation between intake of saturated fatty acids and death from coronary heart disease in the next 10 years in groups of middle-aged men from seven countries. Each letter denotes the mean of one cohort (from ref. 8).

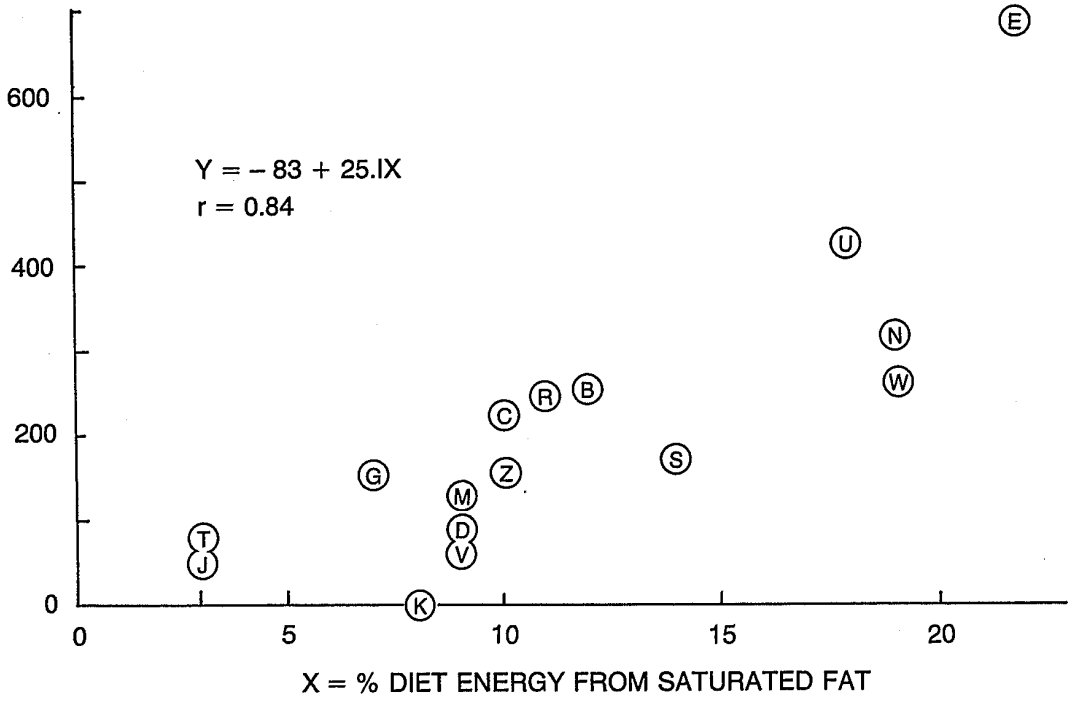

Figure 3. Linoleic acid content of subcutaneous fat tissue of healthy adults in the United States of America and United Kingdom, 1957-1978 (from ref. 6).

The relation between fatty acids, plasma cholesterol and heart disease is discussed abundantly elsewhere. That it is a causal relation is suggested by the results of many different types of research: experiments in animals and man, studies of genetic diseases of cholesterol metabolism, epidemiology, histology, and cellular and molecular biology. This suggestion of a causal relation has been reinforced by the outcome of recent intervention studies, where lowering of plasma cholesterol through dietary (4) or drug (9, 10) treatment conclusively lowered the incidence of coronary heart disease without affecting the incidence of other diseases.

Recent changes in fat intake

Despite the efforts of nutrition educators, there is little evidence that fat intake is falling in any of the affluent populations. Perhaps the pleasure afforded by fat-containing foods outweighs the distant threat of a disease which might strike many years later, if it strikes at all. However, there are interesting trends in the composition of dietary fats consumed. As shown in figure 3, the proportion of the main polyunsaturated fatty acid, linoleic acid, in subcutaneous body fat of Americans has been rising steadily over the past 20 years.

This change agrees with the dietary changes that have taken place in the United States of America: a reduction in animal and dairy fat consumption, and an increased intake of oils. There is some evidence for similar changes in the dietary fatty acid pattern in The Netherlands. In the United Kingdom food patterns have been more stable, and this is reflected in the composition of adipose tissue.

If the trend observed for the United States of America continues and expands to other countries, then we may be enter-

ing another new dietetic phase, where a high fat intake is combined with a high intake of mono- and polyunsaturated and a low intake of saturated fatty acids. Despite much research we still cannot predict with certainty how the human organism will react to this diet in the long term. A careful monitoring of intake trends, for instance by the fat biopsy technique used to produce figure 3 might be valuable for future investigators (2).

Samenvatting
De dagelijkse vetinneming in Nederland bedraagt ca. 85 tot 125 g, of 40% van de energie. Historisch gezien is dit hoog. De prehistorische mens at misschien wel veel vlees, maar weinig (verzadigd) vet. Dit kwam doordat het vlees van wilde dieren, in tegenstelling tot dat van moderne landbouwhuisdieren, weinig vet bevatte, vooral weinig verzadigd vet. Ook in de eerste helft van deze eeuw bedroeg de vetopneming in Nederland nog slechts zo'n 13 tot 32 en%, wellicht omdat vet duur was. De ontwikkeling van landbouw- en voedingsmiddelentechnologie heeft nu echter vet tot de goedkoopste bron van voedingsenergie gemaakt. De toegenomen consumptie van vet, met name verzadigd vet, is waarschijnlijk mede verantwoordelijk voor de toeneming van ischaemische hartziekten sinds 1950. Recent treedt in de Verenigde Staten van Amerika weer een nieuwe trend op n.l. een hogere consumptie van onverzadigde vetzuren bij een gelijkblijvend hoge totale vetinneming. Voor het vaststellen van de effecten op de gezondheid van deze trend is een zorgvuldig vastleggen van de veranderingen in de consumptiegewoonten nodig. Analyse van microbiopsieën van vetweefsel is hiervoor een geschikte techniek.

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Boekbesprekingen

Hof, M. A. van 't, J. J. van Weerden, J. W. H. elvers, A. B. Cramwinckel en K. G. König: Effekt van het Nijmeegse GVO-onderwijs na 7 jaar. Nijmegen 1984. 43 blz.

'Het Nijmeegse GVO-onderwijs heeft geen aantoonbare verbeteringen in gezondheidstoestand of gezondheidsgedrag teweeggebracht bij kinderen aan het eind van de 6e klas'. Dit is de eerste conclusie van bovengenoemd rapport. In dit rapport wordt het effect van 7 jaar GVO-onderwijs met het door het GVO-project Nijmegen ontwikkelde curriculum voor gezondheidseducatie geanalyseerd. Kinderen van 10 experimentele scholen werden vergeleken met kinderen van 10 controlescholen, waar GVO niet systematisch onderwezen werd. Bij de beginmeting deden 438, respectievelijk 371 kinderen mee. Bij de meting in de 6e klas, voorjaar 1983, waren er 231, respectievelijk 179 kinderen die de gehele periode van 7 jaar in het onderzoek betrokken waren gebleven. Er vonden anthropometrische metingen plaats, terwijl ook werd gekeken naar conditie en lichamelijke activiteit, bloedparameters, voeding (totaal aan opgenomen energie, macrovoedingsstoffen, microvoedingsstoffen, cariogene voedingsmiddelen), tandheelkundige aspecten en attitude/kennis.
Het rapport is statistisch-methodologisch van opzet; er is de nodige aandacht voor de keuze van analysetechniek: variantie-analyse met drie ingangen, te weten GVO versus niet-GVO, geslacht en sociaaleconomisch milieu. Voor een niet-statisticus is het rapport niet gemakkelijk leesbaar.
Van de totaal 57 variabelen zijn 7 cruciale variabelen in de uiteindelijke toetsing opgenomen. Bij de keuze golden als criteria: aantal zo klein mogelijk, betrouwbaarheid en validiteit zo hoog mogelijk en theoretisch van belang. Bovendien moesten de cruciale variabelen evenwichtig over de eerdergenoemde categorieën van metingen verdeeld zijn.
Als mogelijke verklaringen voor de constatering dat het Nijmeegse GVO-onderwijs geen opzienbarende veranderingen bij lagere schoolkinderen teweegbrengt stelt het rapport ten eerste dat de Nederlandse lagere schooljeugd in het algemeen in goede gezondheid verkeert.
Ten tweede is de evaluatieprocedure misschien te weinig onderscheidend geweest. De samenstellers van het rapport bepleiten dan ook onder andere bestudering van het effect op langere termijn, bij voorbeeld bij adolescenten en het selecteren van bruikbare evaluatiecriteria, door middel van grootschalig langdurend en multidisciplinair onderzoek.

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Bosch, J.S.G. van den en R. Steendijk: Ongewone en gestoorde groei bij kinderen. Practicum huisartsgeneeskunde. Uitg. Bunge. Utrecht 1984. Prijs: *f* 35,–.

Dit boek is geschreven door een huisarts die over groei van kinderen een proefschrift schreef en een kinderarts, die gespecialiseerd is in groeiproblemen. Het is bedoeld om de huisarts meer informatie te bieden over groei en ontwikkeling van het kind.
Evenals bij de andere delen in de serie 'Practicum huisartsgeneeskunde' wordt uitgegaan van een concrete praktijksituatie. Aan de hand hiervan worden diagnostiek, theorie en advisering besproken. Vooral de normale variaties van het patroon van groei en ontwikkeling krijgen aandacht.
Een greep uit de besproken onderwerpen: kleine jongens, lange meisjes, dikke jongens en een slecht groeiende zuigeling. Ook aspecten van borstontwikkeling en onderzoek op scoliose komen aan de orde, schema's voor de differentiële diagnose van kinderen met een lange of kleine gestalte, seculaire groeiverschuiving in maat en getal, alsmede de standaardwaarde van het landelijk groeionderzoek 1980, maken dit boek tot een geschikt naslagwerk voor de algemene praktijk van de huisarts.
Daar groei en ontwikkeling bij uitstek het onderwerp is van artsen werkzaam in zuigelingen-, kleuterzorg en schoolgezondheidszorg, kan dit boek ook voor hen worden aanbevolen.

H. W. A. Voorhoeve