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SYMPOSIUM ON 'OBESITY IN MAN'

Obesity as a global problem

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How can the enormous number of analytical experiments on adipose tissue be integrated for a better comprehension of obesity? A 'global approach' is an attempt to integrate, determine the relative importance, and give a meaning to analytical results. It starts from an hypothetical and intuitive system which must be checked experimentally.

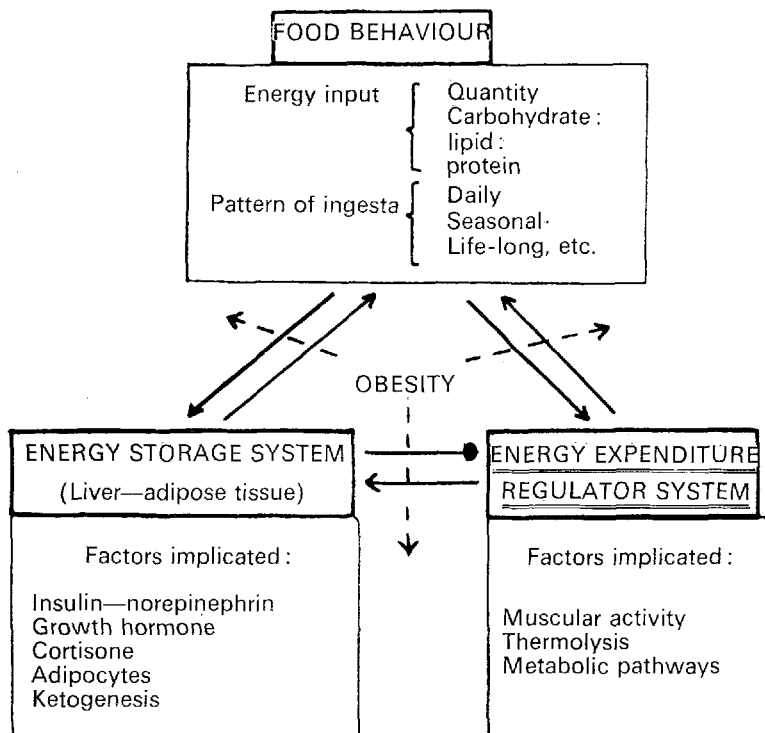
For obesity we will suggest a system which is supposed to represent the general processes implicated in the regulation of adiposity: energy expenditure, fat storage, food behaviour (Fig. 1). Each of these three general processes has to be characterized by a set of measurable parameters which vary relative to one another under stress conditions.

Energy storage

Overeating is a nonsense word as it suggests that a 'normal' level of intake can be established on an individual basis. Overeating may mean an excess of intake over expenditure or an excess of storage.

Physiological approaches. Interrelationships between energy intake, expenditure and adiposity are not the same in the various types of obesity. In the absence of more objective definitions, we suggest five types: (1) the constitutionally obese persons who remain obese when their energy intake is 10–20% above their basal metabolic rate (BMR). This kind of obesity is generally familial or follows severe stress or undernutrition in childhood, being more severe the sooner it appears, or it develops at puberty or after pregnancy; (2) psychogenic obesity of two kinds: (a) those persons who are able to increase their weight without eating more under stress conditions (i.e. increasing their nitrogen and carbohydrate retention (Trémolières, 1970)) and (b) those who do eat more under stress conditions; (3) big eaters, irregularly or regularly, whose intake is much above the average intake; (4) those who are 'unhappy with their shape', or have a distorted image of their bodies; (5) medical forms of obesity resulting from endocrine disorders or complicated obesities.

Logically the carbohydrate pool must be of little importance only, in weight variations, as an increase or decrease of 0.10 g glucose/l body fluid results in a change of 350 g in the body-weight of a person with the ideal body-weight of 70 kg, and an in-



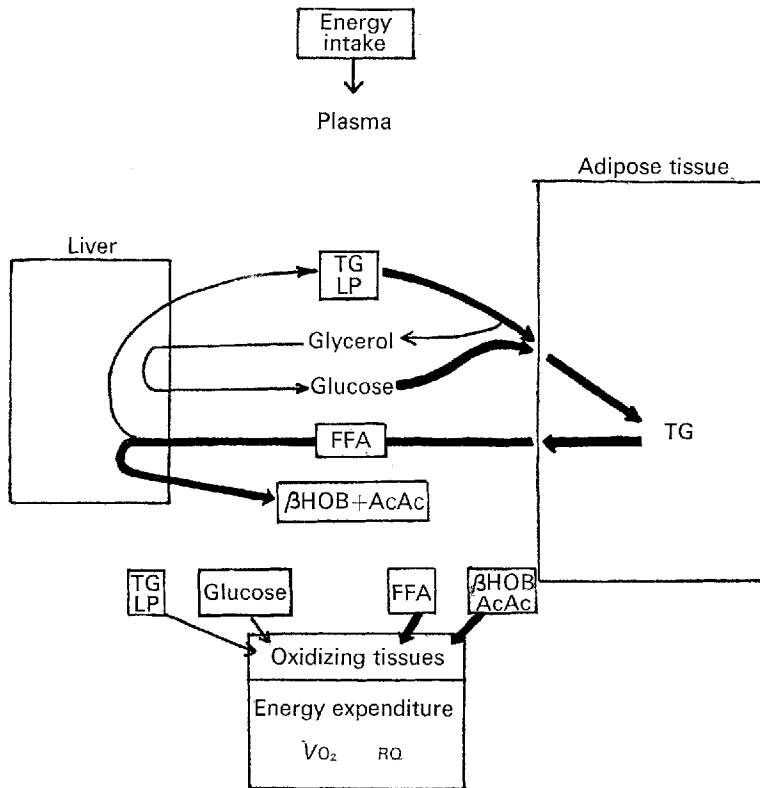
Obesity is a change in the adjustment of these three systems.

Fig. 1. A global scheme for obesity.

crease of 1% in glycogen/50 kg adipose tissue results in an increase of about 1 kg body weight. The basis for the poor weight reduction in persons given the low-energy-high-carbohydrate diet are not clear.

The importance of the pattern of ingestion has been shown by Debry, Rohr, Azouaou, Vassilitch & Mottaz (1968), who found that with a constant energy intake there was a greater weight loss with a daily feeding pattern of seven meals than with three meals. Clinically, many obese people eat irregularly and do not have some meals. A hyperfunctional adipose tissue, storing each excess of intake, could be a possible aetiology. This can be studied either by the measurement of energy expenditure after meals or of suitable biochemical variables in the plasma after an energy load.

Biochemical approaches to the functional capacity of energy storage. Fig. 2 shows the excessive ability of the 'constitutionally obese' either to store fat after a load of 0.5 g triglycerides (TG)/kg body-weight or to increase TG storage after a glucose load of 1 g/kg body-weight. Fig. 3 shows the different pattern obtained with hyperlipaemic (mixed type) subjects given similar treatments. These patterns are based on the following observations of Trémolières, Sautier, Carré, Flament & Plumas



A TG load (0.5g/kg body-wt) does not increase plasma TG, but reduces plasma glucose.

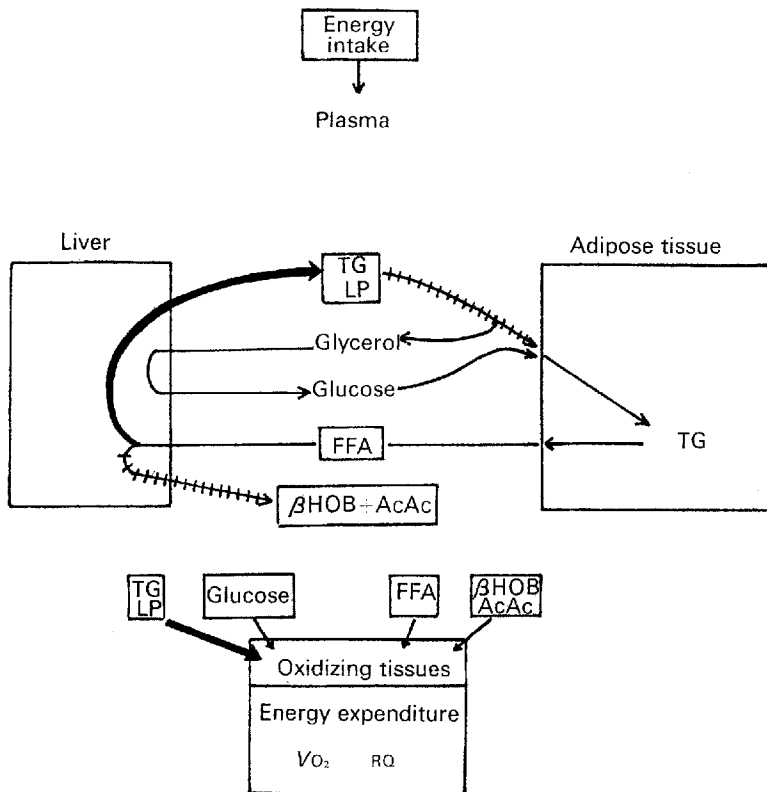
A glucose load reduces plasma TG and increases TG storage.

Reducing energy intake increases levels of FFA, β HOB, AcAc.

Fig. 2. The effect on the constitutionally obese subject of a load of 0.5 g triglyceride (TG)/kg body-wt or 1 g glucose/kg body-wt. \rightarrow enhancement of pathway, TG triglyceride, LP lipid, FFA free fatty acids, β HOB β -hydroxybutyrate, AcAc acetoacetate, VO_2 oxygen uptake, RQ respiratory quotient.

(1973) in studies involving control, obese and hyperlipidaemic subjects; (a) after a load of 0.5 g TG/kg, four obese subjects did not show increased plasma TG compared with four control subjects, but their glycaemia was lowered significantly; they stored the TG load more quickly; (b) after a load of 1 g glucose/kg theoretical body-weight, the obese subjects had significantly lower plasma TG levels than the mixed type of hyperlipidaemic subjects and stored more TG in adipose tissue during hyperglycaemia; (c) when the energy intake was reduced the obese subjects showed a marked and significant increase in their plasma ketone bodies while the mixed type of hyperlipidaemic subjects did not. They also had a greater ability to distribute fat metabolites to peripheral tissues; (d) gas-exchange measurements showed that the obese subjects are able to metabolize fat sooner at the end of a period of fasting than normal and hyperlipidaemic subjects.

We conclude that this type of 'constitutionally obese' subject is able to store and



A glucose load does not reduce plasma TG or FFA.
 Reducing energy intake reduces TG and LP but does not increase
 FFA nor β HOB and AcAc.

Fig. 3. The effect on the hyperlipaemic (mixed type) subject of a load of 0.5 g triglyceride/kg or 1 g glucose/kg. \rightarrow enhancement of pathway, $+-\rightarrow$ diminution of pathway, TG triglycerides, LP lipid, FFA free fatty acids, β HOB β -hydroxybutyrate, AcAc acetoacetate, VO_2 oxygen uptake, RQ respiratory quotient.

mobilize fatty acids (FA) more quickly than either normal persons or the mixed type of hyperlipidaemic patients and is able to circulate more FA in the form of ketone bodies.

Energy expenditure

Reported evidence suggests (Trémolières & Martineaud, 1963) that BMR is nearly normal in obesity when it is related to the amount of exchangeable potassium (K_e/d). Reduction of the energy intake to 0.92 MJ (225 kcal) with a protein intake of 55 g/d reduces the BMR by 20% in 21 d, while the active tissue mass remains constant (Apfelbaum, Bostsarron & Brigant, 1969; Bray, 1969). Skin temperature is normal (Trémolières, Cros & Carton, 1962), but on exposure to cold the obese subject can reduce thermogenesis (Quaade, 1971). The specific dynamic action is normal in

obese subjects but glucose is converted to fat at a lower concentration than in the normal person. Wasteful muscular activity is spontaneously reduced in some obese subjects.

The energy cost of muscular activity is roughly normal in obese subjects, but is lowered by 10–20% on a low energy intake. In the obese on a reducing diet, muscular activity stimulates ketogenesis and results in the metabolism of fatty acids. These factors can be related to the so-called Randall effect in which free fatty acids block glucose utilization (Trémolières, 1970).

Therefore each component of energy expenditure is apparently normal in the obese subject except that these subjects (a) have a special ability to oxidize FA as shown by the low fasting respiratory quotient (RQ) (0.75 compared with 0.80 in normal subjects); (b) have a special ability for lipogenesis from an excess of glucose and (c) with a diet of 2.5–4.18 MJ (600–1000 kcal) and 55 g protein, an obese subject loses about 200–240 g/d for 3 months, that is, his total energy expenditure is normal or even a little high, while with a diet about 10–20% above the BMR some difficult obese patients do not apparently lose weight. This is a clinical fact which has to be studied more carefully with measurements of body composition and energy expenditure. These 'constitutionally obese' subjects apparently have a kind of energy intake threshold above which they develop a process-impairing weight reduction, that is, changing body composition in an unknown way.

Food behaviour

Clinical experience shows that the difficult types of obese subjects often suppress one meal. They eat irregularly, both fasting and eating to excess. They eat quickly in an aggressive and regressive way and stop eating with a sensation of a full stomach and not by an oral sensation. They can be determined to reduce their diet for a period of time but are very unstable in their determination. Anorexigenic drugs are generally no use on a long-term basis as they do not change a behaviour which is deeply rooted in the personality.

General psychological schemes for the treatment of the obese person are not specific for obesity and are of little use practically. Severe obesity which occurs after the administration of tranquillizing drugs would make an interesting biological study as the condition is associated with one known factor.

It is apparently impossible, clinically, to change human dietary behaviour by external influence without taking account of the psychosensorial (i.e. affective) and the symbolic motivations of the food drive. We have proposed a global scheme (Trémolières, 1972). However this is also of little practical use because what the obese person needs is to solve the contradiction between his drive towards eating, the ability of his adipose tissue to store each excess and the image he wants to get of his own body.

The solving of a contradiction which produces a painful distortion is the most difficult and solitary task that concerns each of us throughout our lives. We must believe that it is good to do so and to appreciate that what is good and fair requires its own special attitude to nutrition. A 'global approach' is a process which tries to

give a meaning to analytical, partial and anecdotal results, and we discover that when 'meaning' is related to man, a 'global meaning' is inefficient when it is only objective and logical (that is to say, scientific) and it has to include an affective and symbolic (that is, metaphoric) meaning.

The 'global approach' to a metabolic disease needs more and more thought. Most medical research remains factual and analytical, which is the practice of drug therapy. For diseases related to our way of eating and living habits, a global metabolic and physiological approach is necessary as a basis for changing a behaviour. It is a poorly explored and fascinating field of biological science.

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