Fat and visceral fat: time for cardiologists to act against obesity

Health risk is not synonymous with obesity and obesity is not synonymous with visceral fat

Obesity is now recognised by governments, and importantly in medical training, as a chronic disease leading to multiple organ-specific pathologies (including metabolic syndrome and coronary heart disease). For epidemiological purposes, fatness is still usually classified by body mass index (BMI) – body weight in kg divided by the square of height in cm^2. A BMI greater than 25 kg/cm^2 is classified as overweight, greater than 30 kg/cm^2 as obese and greater than 40 kg/cm^2 as 'morbidly obese'. Across populations, BMI correlates crudely with body fat, but it is a poor guide to body fat of individuals. Misclassifications of individuals occur because body mass includes musculoskeletal mass as well as fat mass. Lean sportspersons, such as a body builder or rugby players, commonly have a BMI > 30 kg/m^2. Further errors in the BMI calculation arise from squaring errors in height measurement which also varies diurnally.

With modern imaging technology including computerised tomography (CT) and magnetic resonance imaging (MRI), investigators have been able to assess compartments of body fat more specifically. Body fat is most simply classified as subcutaneous and visceral fat, and that corresponds with health risks. There are sex differences – females have more fat in total (about a fifth of body weight) with relatively more subcutaneous fat and less visceral fat than males. Within each sex, increased visceral fat is associated with a cluster of metabolic disturbances which are aggravated as total fat mass that increases with age, and which contribute to cardiovascular disease (table 1).

Table 1. Clinical identification of metabolic syndrome: any three of the following

Risk factor	ATP III criteria[1] Any three of these:	IDF proposed criteria[2] Large waist plus any two:
Abdominal obesity	Waist circumference	Waist circumference
- men	≥ 102 cm (> 40 inches)	≥ 94 cm (> 37 inches)
- women	≥ 88 cm (> 35 inches)	≥ 80 cm (> 32 inches)
Triglycerides	≥ 150 mg/dL (1.7 mmol/L)	≥ 150 mg/dL (1.7 mmol/L)
High-density lipoprotein (HDL) cholesterol		
- men	< 40 mg/dL (1.0 mmol/L)	< 40 mg/dL (1.0 mmol/L)
- women	< 50 mg/dL (1.3 mmol/L)	< 50 mg/dL (1.3 mmol/L)
Blood pressure	≥ 130/≥ 85 mmHg	≥ 130/≥ 85 mmHg
Fasting glucose	≥ 110 mg/dL (6.1 mmol/L)	≥ 100 mg/dL (5.6 mmol/L)

Why is visceral fat important?

Visceral fat has its phylogenetic origins as brown adipose tissue. It retains a high blood supply and density of mitochondria, which are metabolically highly active. It generates heat, and also serves as a rapid-access reservoir for fatty acids to be released into the circulation at times of need for peripheral oxidation. Problems arise when the intra-abdominal fat mass is expanded and there is sustained high release of fatty acids into the portal circulation, which interfere with the hepatic clearance of insulin leading to hyperinsulinaemia and also prevents the normal suppression of glucose release from the liver, with consequent insulin resistance. In this setting, the familiar elevation of triglyceride and suppression of high-density lipoprotein (HDL) develop.

Subcutaneous adipose tissue normally functions as a sump to store excess circulating triglycerides, but this requires normal insulin action. It appears that a threshold level of fat mass (different for different people) may define the point where circulating fats can no longer adequately be stored and the metabolic decline into type 2 diabetes ensues. The age of onset of type 2 diabetes (in those who are genetically predisposed) is defined by fatness (figures 1 and 2). However, the metabolic and macrovascular effects of increasing body fat lead to clinical heart disease in people developing metabolic syndrome before the World Health Organization (WHO) criteria for diabetes are reached. The WHO criteria were based on microvascular complications of diabetes. It remains interesting that some people are able to maintain normal blood lipids despite horrific levels of body fat, and there is some evidence that certain fat deposits e.g. the thigh may be especially important.[4]

As evidence has accumulated, it has become clear that metabolic syndrome confers a risk of CHD similar to that of having diabetes, and needs to be treated. The emphasis given

Figure 1. Relation of body mass index (BMI) and age at diagnosis among people with newly diagnosed type 2 diabetes. P for trend <0.0001, based on linear regression of BMI on age at diagnosis[3]

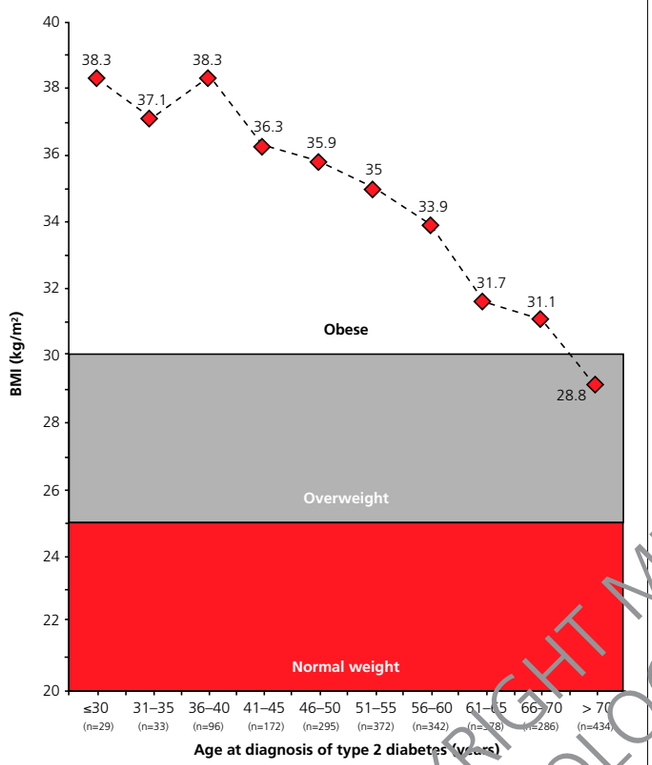

Figure 2. Age of onset of type 2 diabetes mellitus

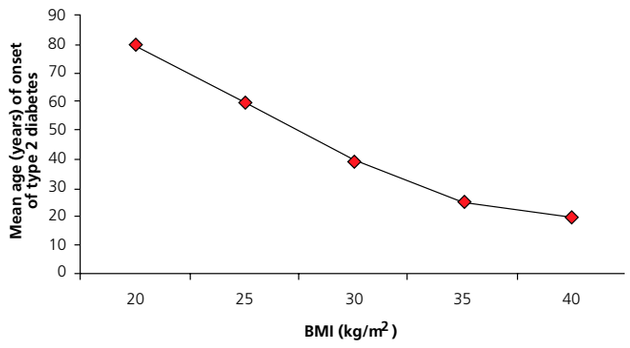

Table 2. Action levels to show cardiovascular disease risk based on waist circumference

	Men	Women	Health risk*
Below action level 1	< 94 cm	< 80 cm	Low risk
Action levels 1 to 2 (Alert Zone)	≥ 94-102 cm	≥ 80-88 cm	Increased risk
Above action level 2 (Action Zone)	≥ 102 cm	≥ 88 cm	High risk

Key: *Risk for type 2 diabetes, coronary heart disease, hypertension

to waist circumference has been increasing. The most widely known criteria from the National Cholesterol Education Program ATP III used a waist cut-off of 102 cm for men, 88 cm for women (i.e. Action Level 2, table 2). More recently IDF (www.idf.com) concern for prevention of diabetes as well as CHD has proposed using 94 cm for men, 80 cm for women (i.e. Action Level 1, table 2).[5] Using the IDF criteria recognises that many more people are at high risk and deserve active management and that many people have already got diabetes and CHD by the time they achieve ATP III criteria. The absolute level of CHD risk is lower using the IDF criteria.

Waist circumference as a surrogate for visceral fat and its use in health promotion

There is now a wealth of evidence that waist circumference correlates highly with visceral fat as well as total body fat. Waist circumference is one of the strongest predictors of the features of metabolic syndrome – indeed it is a key feature of the diagnostic criteria (table 1). Waist circumference has value for health promotion to individuals because of its simplicity in concept and measurement, compared to BMI. Sex-specific 'Action Levels' based on waist circumference were originally defined to raise public awareness of their risks of cardiovascular disease (table 2). These levels are now adopted by bodies such as the British Heart Foundation and Diabetes UK, the World Health Organization[6] and the National Institutes of Health in the USA.[7] The exact level of risk depends on many factors including ethnicity (higher risk for the same waist in Asians), but the cut-offs can be applied to indicate broad risk categories in any population.

Most men, at least, already know their waist size from their trousers. Clothing size correlates strongly with waist circumference and can be used to raise public awareness.[5] For men with a trouser size ≥ 38 inches or for women with a dress size ≥ 18, the age and smoking adjusted odds ratio of having at least one major health problem (ischaemic heart disease, hypertension or diabetes mellitus) are 3.9 (95% CI: 1.8 to 8.3) in men and 7.0 (95% CI: 2.5 to 19.4) in women, compared to a man with a trouser size below 36 inches or women with a dress size below 16, respectively (table 3).

Thus, men's trouser size equal or larger than 38 inches in the UK and [US] or 97 cm in Europe, and women's dress size

Table 3. Age and smoking adjusted odds ratios for ischaemic heart disease and risk factors for 362 subjects with UK and US trouser size ≥ 38 in men and UK dress size ≥ 18 (US size ≥ 16) in women compared to those with UK and US trouser size < 36 in men and UK dress size < 16 (US size < 14) in women respectively (unpublished data from Han and Lean)

	MEN				WOMEN			
	Overall prevalence (%)	Odds ratio Small clothing size*	Odds ratio Large clothing size†	(95% CI)	Overall prevalence (%)	Odds ratio Small clothing size*	Odds ratio Large clothing size†	(95% CI)
Ischaemic heart disease	15.5	1.0	1.9	0.7 to 4.9	11.2	1.0	1.8	0.5 to 6.5
Hypertension	14.9	1.0	4.6	1.6 to 13.2	12.4	1.0	11.3	2.9 to 43.8
Diabetes mellitus	4.5	1.0	3.5	0.7 to 18.4	3.1	1.0	4.2	0.4 to 44.2
At least one of the major cardiovascular risks‡	29.4	1.0	3.9	1.8 to 8.3	23.0	1.0	7.0	2.5 to 19.4

Key: *Reference group: subjects with UK and US trouser size < 36 in men and UK dress size < 16 (US size < 14) in women. †Large clothing size group: subjects with UK and US trouser size ≥ 38 in men and dress size ≥ 18 (US size ≥16) in women. ‡At least one of ischaemic heart disease, hypertension or diabetes mellitus.

equal or larger than 18 in the UK, 16 in the US or 48 in Europe, could be used to promote self-awareness of increased health risks by the general public.

Achieving cardiac patients' weight control by cardiologists?

People with coronary heart disease (CHD) are more overweight than people without, and once they have manifest CHD, further weight gain is common and aggravates all the pathways to occlusive vascular diseases. A recent multinational study of 15 European countries (EUROASPIRE II)[8] on diabetic and non-diabetic patients with CHD showed that about one in three patients (31%) and half of all patients were overweight (48%). Only 21% had a normal BMI. After hospital discharge, patients' body weights had increased by at least 5 kg in a quarter of all patients. In post-myocardial infarct patients the evidence is consistent, if scattered, that reducing elevated body weight will prevent or delay the processes leading to future events.[9,10] It is disappointing for patients that this is not yet addressed routinely or aggressively in rehabilitation programmes.

Pending 'hard outcome' results from long-term weight management studies, we should be reassured that weight control by all the clinical interventions studied are consistent in reducing metabolic risks, by an amount at least as great as with the drugs routinely prescribed under prescribing guidelines for individual risk factors. This applies to the evidence-based drugs, orlistat,[11] sibutramine,[12] and for the investigational drug, rimonabant,[13] even for patients at high risk for CHD. A generation of people with heart disease was denied effective treatment before the hard-end-point trials for cholesterol lowering, despite the consistency of supporting evidence. We now appear to be at that stage with respect to weight management in cardiological practice.

Conclusions

Metabolically active visceral fat is rather specifically related to metabolic disturbances but closely related to total body fat content. Waist circumference correlates highly with this visceral mass and has been shown to predict metabolic risks and CHD better than other indices of adiposity including BMI. Waist circumference is a simple concept and an easy method for self-measurement. It can thus be employed as a simple tool for health promotion to the general public. A high waist measurement is now recognised as the crucial diagnostic criterion for metabolic syndrome. There is no health hazard from treating obesity even when risk factors are absent. Health professionals, particularly cardiologists and endocrinologists can prevent further health deterioration for their patients by promoting weight management as keenly as the drug therapies directed at individual risk factors.

Conflict of interest

None declared.

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