

Management of obesity and overweight

Michael EJ Lean

Abstract

Modern weight management incorporates optimization of health and risk factors, irrespective of weight change, short-term weight loss and long-term prevention of weight gain/regain. Patients with excess body fat and elevated metabolic risks needing professional weight management can be identified by a large waist (>102 cm for men, >88 cm for women). A modest weight loss of 5–10 kg is achievable by many conventional dietary intervention methods, with multiple small benefits. However, this is usually insufficient to improve quality of life sufficiently for people to maintain their reduced weight. A target loss of 15 kg is now recommended for severe and medically complicated obesity, for example to obtain remission from type 2 diabetes mellitus. A structured programme addressing diet and physical activity and behavioural management, as used in the UK Counterweight Programme and the DiRECT trial for type 2 diabetes remission, is cost-effective in generating <15% weight loss for 20–30% of patients who attempt it. Used with good dietary support, most available anti-obesity drugs are generally safe, and usually double the weight loss and clinical benefits of diet and exercise. Newer glucagon-like peptide 1 (GLP-1) agonists, for example semaglutide, achieve mean weight losses of >10 kg. Bariatric surgery, improves multiple health risks and extends life expectancy for extreme obesity (body mass index >40 kg/m²). However a target of >15 kg loss, in line with patients' wishes, is sufficient on medical grounds, and is becoming more achievable within primary care.

Keywords Bariatric surgery; counterweight-plus programme; liraglutide; MRCP; orlistat; total diet replacement

Introduction

The emergence of obesity as a distinct disease with complex genetic and environmental aetiology, underpinning a huge raft of secondary chronic pathologies, presents new issues for health services and also potential conflicts for doctors, relating to the aims and demands of treatment. Obesity is in principle a totally preventable, and totally correctable, highly visible disease. However,

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Key points

- Obesity is gradually becoming recognized as a *disease process* rather than merely a state of having reached a body mass index (BMI) >30 kg/m². Its treatment requires alterations in that disease process
- It is rapidly being recognized that the major diseases associated with diabetes, particularly with type 2 diabetes mellitus (T2DM), are causally related consequences of the disease process of obesity (not merely 'co-morbidities'). Therefore effective treatment of T2DM should tackle the underlying obesity process, to reduce the excess fat accumulation that drives diabetes – not just lower the blood glucose and leave the disease progressing
- Governments including the UK's are beginning to recognize the scale of harm that results from an unregulated food industry, selling more to increase profits, but hereby generating externalities in terms of obesity and T2DM
- New drug classes, especially glucagon-like peptide 1 (GLP-1) agonists, are offering greater weight losses and better safety for long-term maintenance than previously possible. They are now approved and licensed as effective and safe in most countries, but (for cost reasons) are not yet covered by all insurance plans or recommended by agencies such as the National Institute for Health and Care Excellence in England or the Scottish Medicines Consortium in Scotland
- Modest weight loss of 5–10% improves all risk factors and reduces the incidence of T2DM by 58% in people with impaired glucose tolerance. Greater weight loss (>15 kg) is necessary to restore normal glucose tolerance in patients with T2DM; it is now the target recommended by national guidelines for severe and complicated obesity, and is achievable using new evidence-based non-surgical programmes

its correction is commonly in opposition to the hedonic principles encouraged by post-industrial free-market economies. Its prevention (both primary and secondary) requires the permanent establishment of changes in behaviours that affected individuals have assumed life-long to be normal. As with smoking a generation ago, health professionals should be giving clear evidence-based guidance, and also putting their own house in order, to avoid giving conflicted messages to patients and the public.

Aims and criteria of success in weight management

The justification for treating obesity is founded on the overall burden of ill-health incurred by individuals over time, and on its enormous cost to health services (from conditions resulting from weight gain). There is increasing evidence for both short- and long-term clinical benefits of weight loss but emphasis has shifted towards finding effective evidence-based methods for weight maintenance, to avoid weight (re-)gain. Modest intentional weight loss (5–10 kg) has major impacts on metabolic risk

BMI and waist circumference cut-offs in groups and populations for public health assessment and health promotion

	Healthy normal range	Health risks increasing Make personal changes to control weight	High risk Seek professional help and management
BMI (kg/m ²)	18.5–25	25–30	>30
Men – waist (cm)	<94	94–102	>102
Women – waist (cm)	<80	80–88	>88

These figures apply to white individuals. Lower figures apply to people of Asian origin, who have greater health risks.

Table 1

factors and, if maintained, leads to important long-term health gains, such as prevention of type 2 diabetes mellitus (T2DM). Greater weight loss (>15 kg) is necessary to reverse some complications of obesity (e.g. in T2DM). Although a maintained weight loss of 5–10% has been the stated goal of weight-management strategies and guidelines for several decades, long-term success has been very limited. This is because the considerable sustained effort required to achieve and maintain a 5–10% weight loss is seldom rewarded by sufficient improvement in quality of life.

Most individuals gain weight gradually during adult life, reaching a plateau by about 60–65 years old. The rate of weight gain varies; the average is 15–20 kg between the ages of 20 and 60 years. In those who become obese, a gain of 1–2 kg/year is average and 5–10 kg/year is common. The rate of weight gain is most rapid in adolescence and early adulthood, and declines with age. Only a small minority of individuals now maintain throughout adult life a ‘normal’ body mass index (BMI) of 18.5–25 kg/m², which is associated with the lowest risks of many problems. This is an unattainable goal for most people who have exceeded BMI 30 kg/m².

BMI is a complicated function; waist circumference (Table 1) is more practical and provides a better guide to both total body fat and future health risks. Waist circumference is widely described as indicating ‘abdominal obesity’, a term that is confusing and which has no definition. Waist circumference reflects intra-abdominal fat mass among groups of people with

similar total body fat content, or similar BMI. However, in most studies, and in population surveys, variations in *total body fat* have more influence on waist circumference than do variations in intra-abdominal fat.

Recent surveys show some decline in the obesity epidemic, as indicated by age-standardized BMI prevalences rising less rapidly, but with better general health and less smoking, weights are now increasing into older ages, up to age 70, with a dramatic rise in waist circumference, in older people, especially in women >50 years. This reflects a continuing increase in body fat content, with less rise in weight, pointing to more frequent sarcopenic obesity, with its close association with frailty and falls, in older people.

Figure 1 shows possible criteria for success in weight management, taking as an example an intervention when the individual reaches a BMI of 25 kg/m². Any reduction in the trajectory of adult weight gain can be considered a success. Remembering the powerful interaction between other risk factors and obesity, the first level of success should be a change in lifestyle to reduce other risk factors, even if weight gain is not modified.

The success of any weight management programme must be evaluated over a relatively long period. Obesity-prone individuals often experience large fluctuations in body weight for social, personal and other reasons. Weight loss is usually short term and cannot be considered the sole criterion of success. It is inappropriate to initiate any treatment outside a programme aimed at results in 12 months or more.

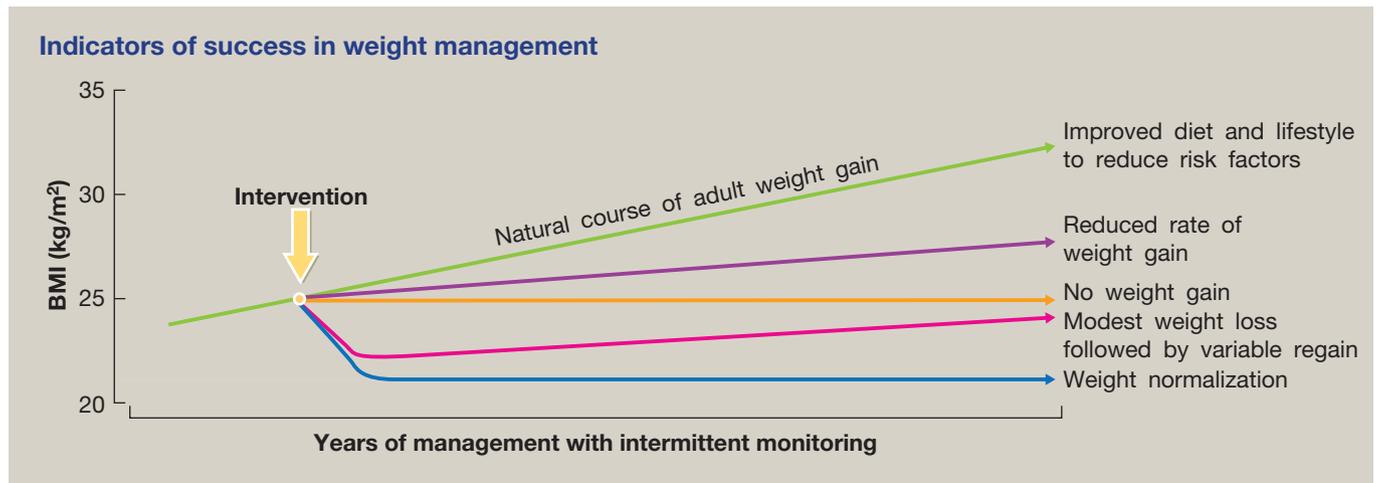


Figure 1

Expected initial weight loss and likelihood of medium-term maintenance

	Mean loss (kg) ^a	Approximate 1–2-year weight loss maintenance (% of initial loss)
‘Do-it-yourself’ self-help	0–10	10
Conventional dietitian	4–5	40
Plus behavioural input	5–10	50
Plus drugs	5–12	80
Total diet replacement	10–20	10
Plus food reintroduction and weight-maintenance support	–	70
Surgery	10–50	80

There is usually regain from 2 to 5 years after all treatment, including bariatric surgery.

^a Mean loss in RCTs to test a treatment usually includes non-responders, whose treatment would be stopped and changed in routine care.

Table 2

On average, overweight and obese patients can lose weight for 3–4 months, but beyond this it is unreasonable to seek further loss. Instead, it is more logical to concentrate on developing skills and confidence for maintaining the lower weight or restricting future weight gain. Prevention of weight gain should always be the primary aim of management, because it represents a cure for obesity (defined as the disease process of excess fat accumulation with multiple organ-specific pathological consequences). Initial weight loss can be induced by a wide range of interventions (Table 2), including simple dietetic advice and follow-up, and most patients know how to lose weight.

In contrast, evidence for the efficacy of treatment in maintaining a lower weight is limited. Surgical intervention (e.g. gastric bypass) is effective in about 90% of patients, albeit at the cost of adverse events that would be unacceptable with drug treatment. Anti-obesity drugs are only effective if a good programme of dietary advice and support is also provided, and the small number of anti-obesity drug trials that have been prolonged beyond 1 year have been effective in most individuals, with around 60–70% maintaining >5% loss. The new glucagon-like peptide-1 (GLP-1) agonist drugs, notably semaglutide, have introduced a new and potentially game-changing capacity, demonstrating sustained weight losses of >10% for half and >15% for about a quarter of individuals – again provided good dietary support is provided.

Among behavioural, dietary and lifestyle interventions, a review of the literature suggests that prolonged and regular professional contact is most important and that physical activity has a smaller role, but the value of other approaches is variable. Different approaches suit different individuals. Several options are available, perhaps presented to the patient as a menu, and the therapist’s skills are of paramount importance.

A comprehensive national guideline to integrate prevention and active weight management, based on published evidence,

was produced in 1996 by the Scottish Intercollegiate Guidelines Network (SIGN; Figure 2). Its conclusions were largely retained in a full review in 2010, and in the English 2006 National Institute for Health and Care Excellence (NICE) guideline.^{1,2} The grading system for scientific evidence (similar to that used for systematic reviews and the Cochrane Library) can be misleadingly incomplete in obesity research, as it relies heavily on placebo-controlled trials. This approach can be impossible or misleading when the trial treatment is long-term lifestyle modification and when individuals often instigate their own, personal approach to ‘treatment’ (they tend to vary the prescribed treatment when the aim is one as familiar as weight loss). For these reasons, even the best research can fail to appear in systematic reviews. For service development, the randomized controlled trial (RCT) is generally inappropriate (other than for specific treatment components), and some form of continuous improvement methodology is preferred.

For most clinical outcomes of weight management, a target of 5–10% loss has been adopted in clinical guidelines. This can be achieved by many methods in community settings, and many medical complications of obesity are greatly improved. However,

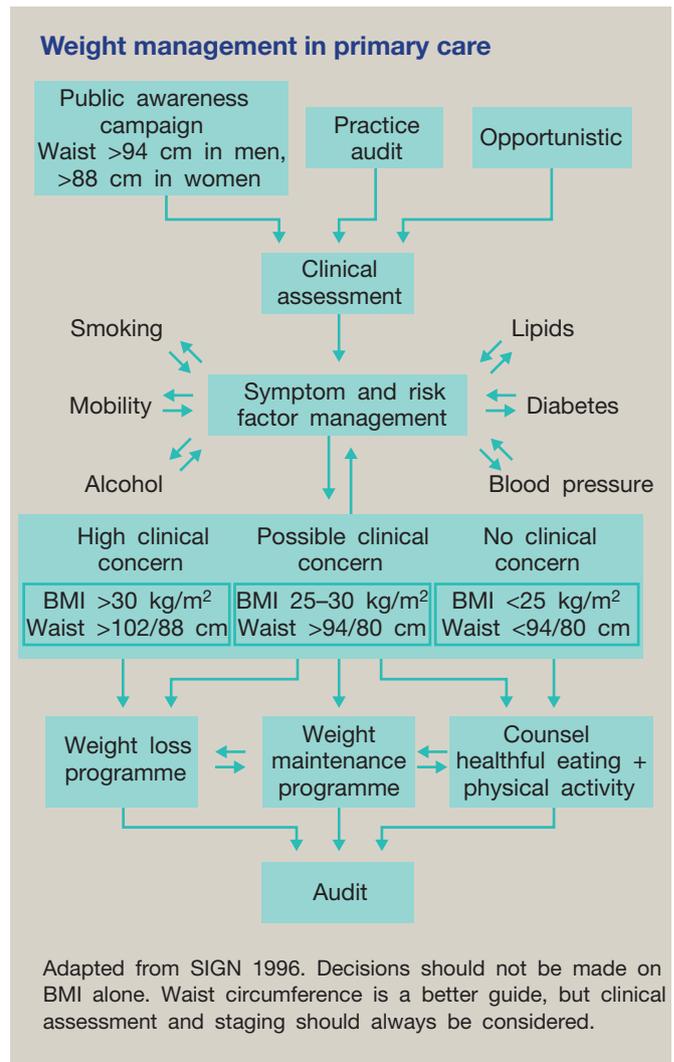


Figure 2

this is changing. RCT evidence from both bariatric surgery and non-surgical dietary programmes has confirmed observational data that a target weight loss of >15 kg reliably reverses the diagnosis of T2DM into remission (within 6 years of diagnosis). This target has been adopted as the target for severe and complicated obesity in the national SIGN guideline 2010 (see Further reading).

Health promotion

The prevalence of obesity (identified by the epidemiological cut-off of BMI >30 kg/m²) is now about 25% (i.e. >15% – the World Health Organization (WHO) criterion for a nutritional epidemic). It is beyond the scope of healthcare services to control this problem solely on a one-to-one clinical basis. The burden of disease would be greatly reduced by small reductions in rates of weight gain achieved by health promotion and other preventive measures. Health promotion can alert the population to the need to take action in the form of personal lifestyle changes or self-referral. Public awareness campaigns based on waist circumference encourage self-referral of those with weight problems before they develop secondary diseases. Practice audit and opportunist screening are other approaches.

The content of health promotion programmes has varied. For both weight loss and for prevention of unwanted weight gain, the emphasis must be on diet, with lesser emphasis on physical activity, although the role of physical activity is proportionally greater for prevention. In terms of diet composition, very large numbers of studies have failed to find evidence favours either high- or low-carbohydrate diets. Both can be effective, the choice determined by individual preferences and current fashion. Extreme low-carbohydrate diets tend to deplete the body of some essential micronutrients, and most people find them difficult to adhere to in the long term.

Health promotion usually attempts to persuade people to change the eating and activity patterns they and their families have adopted and assumed to be completely normal and enjoyable. These include making changes to the composition of foods and meals, and patterns of eating, for example between-meal snacking, which has become usual behaviour over the past 50 years, coinciding with the rise in obesity.

Advice to make dietary changes to improve health have the greatest benefit for better educated people, and are relatively ineffective for those in less educated and more deprived circumstances, where obesity is most common and health poorest. As an alternative, ‘health-by-stealth’ approaches, using covert alteration of food and meal composition, benefitting all consumers without requiring them to make and decisions or conscious effort. To avoid obesity, this will most effectively involve reductions in fat (9 kcal/g) and sugar (3.75 kcal/g) content. A well-accepted example is the Eat Balanced pizza, which was designed to include, in a single pizza meal, one-third of the daily requirement of all the essential nutrients for humans, while still made from natural ingredients and looking and tasting exactly like a good pizza.

The introduction of sugar taxation for some beverages has recently been shown to encourage the behaviour changes urged by health promotion, provided the tax is visible and large enough. The taxation has also led to reformulation of products to

bring them below tax thresholds, adding an element of ‘health-by-stealth’. It is unlikely that these small reductions in sugar consumption alone will significantly affect the obesity epidemic, so future measures need to introduce more powerful taxation with lower thresholds, and be applied in similar ways to result in lower fat consumption.

Clinical management

The first stage in weight management is an assessment of overall health and compounding risk factors.

Symptoms related to overweight (tiredness, sweating, shortness of breath, poor sleep, back pain, arthritis, angina, stress incontinence, menstrual disturbances) should be documented. Some coincidental conditions (e.g. hypothyroidism, breast cancer) can be masked by obesity.

Cardiovascular risk factors (smoking, hypertension, hyperlipidaemia, diabetes mellitus, impaired glucose tolerance) should be dealt with independently of weight loss, as a priority. Weight loss and maintenance are of major value in reducing these risks, with or without additional risk factors, but obesity acts synergistically to increase risk of coronary heart disease.

Greater physical activity and better diet (e.g. five fruit/vegetable portions per day) improve health even without weight loss.

Alcohol, which contains 7 calories/g (fat contains 9 calories/g, carbohydrate 3.75 calories/g), does not stimulate or increase substrate oxidation and tends to increase appetite. Heavy drinkers can be identified by elevated γ -glutamyl transferase (although this is also elevated in overweight individuals with fatty liver, a feature of central fat accumulation particularly associated with impaired glucose tolerance). It is usually not worth embarking on other measures of active weight management while patients continue to drink excessively.

Thyroid-stimulating hormone should be measured to exclude hypothyroidism, which can be difficult to diagnose clinically. Hypothyroidism does not usually cause massive weight gain, but it impedes weight loss and should be corrected early.

Prescribed and self-prescribed drugs should be evaluated. Various drugs increase appetite and promote obesity (Table 3), and can be stopped or replaced with less obesogenic drugs. Obese patients often spend large amounts of money on ineffective, non-evidence-based, proprietary treatments.

The approach to weight management depends on the starting BMI (or waist circumference), the presence of clinical complications such as T2DM, and the patient’s wishes. Engaging partners and families increases effectiveness and sustainability.

Patients with BMI >35 or >30 kg/m² in the presence of T2DM or sleep apnoea (a condition where breathing stops intermittently during sleep, usually marked by snoring) are at high risk of chronic disabling, potentially fatal, metabolic diseases. A target of >15 kg loss, or more for very obese individuals, demands initial weight loss with very low-energy diets (VLEDs) and active long-term measures to prevent regain. Bariatric surgery and anti-obesity medication are appropriate.

Patients with BMI >30 or BMI >25 kg/m² (or waist >102 cm in men, >88 cm in women) in the presence of T2DM are likely to have multiple symptoms, particularly if aged >40 years, and to develop secondary diseases. They should be helped to lose as much weight as possible in a 3-month period. Diet and lifestyle

Drug classes that promote weight gain³

Drug	Main use
Insulin, sulfonylureas, thiazolidinediones	Diabetes
β-Adrenoceptor blockers	Hypertension
Corticosteroids	Various inflammatory diseases
Cyproheptadine	Allergy, hay fever
Antipsychotics	Psychosis
Sodium valproate	Epilepsy
Some steroid contraceptives	Contraception
Most antidepressants	Depression, chronic pain
Lithium	Bipolar disorder

Table 3

methods can be used; the most rapid results are achieved with very low-energy diets (VLED) under supervision. Achievable weight loss in this time should be about 10–15 kg, which is a reasonable aim. Many patients lose less, but a loss of 5–10 kg has medical benefits (Table 4) and should be considered a success. Even those who lose <5 kg cannot be deemed to have ‘failed’, provided their weight has not continued to increase along its expected trajectory.³ After 3 months, it is important to offer the patient a structured management programme for weight maintenance, which is the long-term aim.

Patients with BMI 25–30 kg/m² (or waist 94–102 cm in men, 80–88 cm in women) without medical complications can first be offered either a 3-month weight loss programme or a 3-month weight maintenance programme. The long-term aim is prevention of weight gain, and it is important for patients to learn how to achieve this. Weight loss is less necessary in this group and depends on the presence of associated risk factors and the patient’s wishes.

Potential benefits of modest (5–10 kg) weight loss

- Newly diagnosed T2DM
 - Decrease of 50% fasting glucose
- Blood pressure
 - Decrease of 10 mmHg systolic
 - Decrease of 20 mmHg diastolic
- Lipids
 - Decrease of 10% total cholesterol
 - Decrease of 15% low-density lipoprotein
 - Decrease of 30% triglycerides
 - Increase of 8% high-density lipoprotein
- Mortality
 - Decrease of >20% total mortality
 - Decrease of >30% diabetes-related deaths
 - Decrease of >40% obesity-related cancer deaths

Sources: Scottish Intercollegiate Guidelines Network, 1996; Williamson et al., 2004; Goldstein DJ. Beneficial health effects of modest weight loss. *Int J Obes* 1992; 16: 397–415; Lean MEJ, Powrie JK, Anderson AS, Garthwaite PH. Obesity, weight loss and prognosis in type 2 diabetes. *Diabet Med* 1990; 7: 228–33.

Table 4

Patients with BMI <25 kg/m² (or waist <94 cm in men, <80 cm in women) need healthy eating advice and guidance for avoiding weight gain (obesity prevention). Some require counselling for eating disorders. If T2DM is already present, weight loss is essential. A 15 kg loss target can still be appropriate.

Weight-management programmes

Components of a 3-month weight loss programme

Ultimately, weight loss is always achieved (and can only be achieved) when calorie intake is less than calorie output. Increasing calorie output is difficult in obese individuals, because physical activity is already elevated by carrying extra weight, and there is greater risk of damage to joints and the back. Physical activity is an efficient process and expends remarkably little energy; used alone, it usually results in little weight loss. Patients should therefore limit energy intake, while maintaining physical activity to preserve muscle mass, and subsequently increasing physical activity if possible.

Diet composition: standard fixed diets are less effective than individually prescribed eating programmes based on energy requirements. An energy deficit diet of about 600 calories/day below the predicted metabolic rate (Table 5) achieves a weight loss of 0.5–1 kg/week. Individuals are more likely to adhere to this more generous diet than a fixed 1200 kcal/day or 1500 kcal/day.

Weight loss is achievable by any restrictive diet. Low-carbohydrate diets lead to glycogen depletion and consequent loss of body water, so can appear more effective if only weight loss is measured. Appetite is most likely to be satisfied by a diet relatively high in carbohydrate and protein, and low in fat. This

Estimation of basal metabolic rate (BMR) and daily energy expenditure from body weight (W) and activity level, and its use in prescribing energy-deficit diets

Age (years)	BMR	Activity level (kcal/day)	24-h energy expenditure (kcal/day)
Men			
10–18	17.5 × W + 651	Inactive	BMR × 1.30
18–30	15.3 × W + 679	Light	BMR × 1.55
30–60	11.6 × W + 879	Moderate	BMR × 1.78
>60	13.5 × W + 487	Heavy	BMR × 2.10
Women			
10–18	12.2 × W + 746	Inactive	BMR × 1.30
18–30	14.7 × W + 496	Light	BMR × 1.56
30–60	8.7 × W + 829	Moderate	BMR × 1.64
>60	10.5 × W + 596	Heavy	BMR × 1.82

Example: For a 75 kg housewife aged 50 years: BMR = 8.7 × 75 + 829 = 1482 kcal/day. Daily energy expenditure = 1482 × 1.56 = 2311 kcal/day. To achieve weight loss, subtract 500–600 kcal/day – in this example, 1800 kcal/day should be prescribed. Standard deviations of differences between actual BMRs and estimates are about 150 kcal/day in men and 120 kcal/day in women. The activity factor assumes that 20 min/day of ‘cardioprotective’ exercise at 60% maximal work output is also prescribed.

Table 5

composition is also the one most likely to lead to long-term weight maintenance and is therefore preferred.

Weight loss can be achieved with a wide range of diet compositions. The ketogenic, low-carbohydrate diets used in the past are no longer recommended; they achieve weight loss (no better than that with high-carbohydrate diets), but once weight has stabilized they tend to increase cholesterol and impair glucose tolerance. Weight regain is often rapid. The theory that ketones suppress appetite is not supported by evidence and seems unlikely, given that ketosis was only found during starvation during our evolution, in circumstances that necessarily increase appetite.

Low-calorie formula diets (<1000 kcal/day) are effective and improve coronary heart disease risks and diabetic control, but should not be used without an effective means of preventing weight regain. There is no advantage in using VLEDs (<800 kcal/day), which are less well tolerated. There were safety concerns with badly formulated commercial modified fast diets in the 1960s, but modern nutritionally complete formula diets are safe.

The best evidence is now for low-calorie, nutritionally complete formula diets of 800–1000 kcal/day for the weight loss phase.⁴ This is used as ‘Total Diet Replacement’, meaning that the patient does not have any other food or drink for several weeks of intensive weight loss (15–20 kg over 8–12 weeks). During this time, retraining starts to prepare the patient for the reintroduction of foods and meals, and then for long-term weight maintenance. To gain trust and adherence to the programme, it is vitally important to be flexible, allowing days or weekends for normal human activities and celebrations, with clear guidance on how to handle such periods without reverting to a weight gain diet. Advice to increase physical activity should be reserved for patients who have completed the weight loss phase, and should then be increased cautiously (as they are usually still substantially overweight and risk damaging joints).

The dietary profile for healthy weight loss and maintenance should be compatible with that for health in the general population. Conventional recommendations (e.g. a minimum of five portions of fruit or vegetables per day) apply. Slimming diets based on low-fat approaches lead to improved blood lipids compared with low-carbohydrate diets giving the same degree of weight loss. Long-term results favour low-fat, higher-carbohydrate diets. Low glycaemic-index diets can offer metabolic advantages but do not usually lead to greater weight loss, and can limit intake of some important foods with other nutritional value (e.g. bread).

Eating behaviour: some mystique has come to surround ‘behavioural therapy’, but many well-publicized formal models (e.g. cognitive behavioural therapy, motivational counselling) have not yet been shown to have any advantage over common-sense approaches. Obese patients need advice on how to eat, where to eat, when to eat and possibly with whom to eat. The eating habits of overweight individuals are often disorganized. Simple advice introducing discipline is valuable, for example regular meals, keeping a food diary, planned shopping lists, and eating only off a plate and only with cutlery (no fingers except for fruit).

It can help to negotiate behavioural changes with patients, seeking a commitment to adhere to a specific new rule (e.g. no

butter or margarine, or porridge every morning) for a period of 8 weeks, and then evaluating its continuation or adoption of new measures. Guidance is often required for eating out and entertaining.

Physical activity: a first stage in weight management is often to identify and minimize periods of total inactivity (e.g. television watching). Activities involving human contact, particularly during evenings, promote movement and reduce the inclination to snack. The principal need during weight loss is to maintain muscle mass with relatively low levels of activity (e.g. walking rapidly for 30 min daily). The exact level must be negotiated with the patient, who must then adhere to it. As fitness increases, activity can be increased; it is important in long-term weight maintenance. In some regions, physical activity in, for example, aerobic classes can be prescribed, but no value for weight loss has been demonstrated. Patients can also be encouraged to make a financial commitment to improve their health.

Self-esteem: many overweight patients have low confidence and self-esteem. Their weight interferes with personal, social and occupational activities. Unemployed individuals tend to be overweight, and weight increases when employment is lost. Self-esteem can be improved by giving praise for healthy changes in lifestyle. Employment outside the home improves confidence; steps towards this include unpaid activities such as voluntary work, evening classes or social activities. It is also essential to find personal rewards and treats that are not food-based.

Delivering a structured programme for weight loss: although weight management has been contracted to commercial organizations in some UK areas, evidence does not strongly suggest better or more cost-effective care. Good primary care management needs a properly structured multidisciplinary approach, but delivered by one individual.

Few specialized skills are uniquely available for commercial or hospital-based management, and attendance is likely to be better with trained staff in a community setting. A ‘rolling programme’ of weekly or fortnightly sessions ensures that adequate reinforcement is provided at the end of 12 weeks. The need for a multicomponent programme delivered by a single therapist emphasizes the importance of specific training. In primary care, a practice nurse is often asked to take responsibility for weight management. Formal training is vital, but does not need to be long or burdensome. It is essential that other members of the primary care team (importantly, doctors) understand the principles, difficulties, aims and success criteria of weight management.

The Counterweight Programme provides training and resources for nurse-led weight management in primary care, and evidence for its effectiveness has been published (30–40% of patients maintain 5–10 kg loss at 1–2 years). It is highly cost-effective, and even cost-saving, by avoiding long-term costs from disease secondary to obesity. Counterweight generates its evidence base by continuous improvement methodology, not by expensive and wasteful randomized trials. It has been funded for routine use within the National Health Service in Scotland, and in some English regions.

Evidence indicates that results can be acceptable and more cost-effective with group approaches. Specific training in running groups is required. However, it must be recognized that some patients find groups threatening, so a class approach, perhaps with the option of one-to-one consultations, may be preferred. The most vulnerable patients often fail in group sessions.

Weight maintenance

Although people find it relatively easy to lose weight, especially using a total diet replacement approach, they commonly find reintroduction of foods, and meals, difficult and even threatening, as it was their response when confronted with foods and meals that previously generated their weight gain. The process of re-establishing a food-based 'new normality' diet takes time and requires trained support. Success tends to be greatest when the amount of weight loss is large, implying that the improvement in quality of life is large enough to offset the loss of some enjoyable foods and eating habits.⁵

Cycles of classes or group sessions in weight management, with guidelines similar to those for weight loss, should be provided. Regular contact with health professionals, increased physical activity and a low-fat, higher carbohydrate diet are known to improve long-term weight maintenance.

There is little experimental evidence for weight maintenance. Simply switching to a lower fat products (compared with the usual high-fat diet of developed countries) has been shown to reduce weight gain by about 0.5 kg over 6 months, without restricting food consumption. An overweight population tends otherwise to gain weight at 1 kg/year, so this approach can be valuable if sustained life-long. Removing specific high-energy foods or food groups reduces weight gain, provided there is no compensation from other energy sources. Thus, cutting out sugar-sweetened beverages reduce weight by about 0.8 kg, but replacing the same number of calories from other food sources blocks the effect. As with weight loss diets, any regimen which restricts calorific food choices is likely to result in better weight loss maintenance.

Drugs in obesity

Several drugs provoke weight gain (Table 3), for various reasons. When prescribing them, it is important to discuss this hazard and offer weight maintenance advice, especially to those who are already overweight. Alternative treatments that do not cause weight gain are usually available.

Many drugs cause weight loss through nausea or other adverse effects. A few have been used therapeutically, primarily to reduce food intake (currently liraglutide, the naltrexone–bupropion combination and lorcaserin) or increase energy loss (β_3 -stimulant thermogenic agents, tetrahydrolipstatin to inhibit fat digestion and absorption). They all induce weight loss significantly more than is achieved by diet alone (about 3–5 kg) by inducing an energy deficit of about 300–400 kcal/day; therefore when used with good dietary advice, they can potentially maintain a body weight reduction of 10–15 kg. The average weight losses, however, tend to be smaller, for a variety of reasons including incomplete compliance with both drug and diet.

Drugs prescribed for obesity treatment, or for the treatment of T2DM, are always used as adjuncts to diet and lifestyle advice

and support: pharmaceutical trials that fail to include optimal dietary support are unethical. No drug can produce major and sustained weight loss when used alone, so the management of overweight patients remains multifactorial. Some patients find it impossible to adhere to dietary and lifestyle modification, and in these individuals adjunctive drug therapy can be considered and continued if effective. The main aim is to prevent weight gain or regain. Drugs induce weight loss slowly and can be more appropriate in long-term maintenance after weight loss by other means (e.g. a VLED). Criteria for drug therapy vary. BMI >30 kg/m² is a clear indication; at BMI 25–30 kg/m², the presence or high risk of medical complications such as T2DM may justify their use. Anti-obesity drugs are inappropriate in pregnancy and in children. The adverse effects of centrally acting agents can be greater in elderly people.

Orlistat – (tetrahydrolipstatin), now available without prescription in most countries, is almost entirely unabsorbed into the body and exerts its effect by competitive inhibition of intestinal lipase. To be absorbed, dietary fat (triglycerides (triacylglycerols)) must be hydrolysed by lipase. Orlistat is taken three times daily, before main meals, and leads to malabsorption of about 30% of consumed fat. Provided total fat consumption is less than about 90 g/day, this produces no symptoms. If the patient maintains a high-fat diet, however, detectable steatorrhoea occurs. Gastrointestinal symptoms reported by patients taking orlistat are therefore desirable effects of the drug. Minor depletion of fat-soluble vitamins has been reported with prolonged use, but not to deficiency levels.

The clinical benefits of orlistat result from the malabsorption of about 30 g fat/day, reducing absorbable energy consumption by about 300 kcal/day. Orlistat should only be used in patients who can adhere to a low-fat diet ($<30\%$ energy as fat). Above this, fat malabsorption becomes intolerable, resulting in either correction of the diet (and weight loss) or discontinuation of the drug (and no weight loss). In patients who achieve 5% weight loss at 12 weeks, orlistat can be continued long term, and clinical trial evidence suggests that a mean weight loss (subsequently maintained) of 10–15% can be expected. All cardiovascular risk factors improve with the weight loss. Serum lipids decrease slightly more than expected because of fat malabsorption. The mean additional weight loss of 3 kg with orlistat is maintained for at least 4 years and reduces the incidence of new diabetes by $>30\%$, in addition to the benefits of diet and exercise.

Liraglutide – is a GLP-1 agonist that is licensed for treatment of obese patients with T2DM and, in higher doses, to treat obesity in people with or without diabetes. In obese patients, together with a good diet and exercise programme, it has proved highly effective for weight management, and also markedly reduces blood pressure, in doses of up to 3 mg/day by subcutaneous injection. Mean weight loss of around 8 kg at 1–2 years has been reported. It is rapidly becoming the preferred drug treatment for obese patients with diabetes. The main adverse effect is nausea, which can be avoided by dose reduction and by taking injections later in the day.

Semaglutide – is a second-generation, more potent GLP-1 agonist that reliably produces weight losses $>10\%$, commonly $>15\%$. It requires only a small weekly injection, but as always needs the patient's personal effort to reduce energy consumption. Both liraglutide and semaglutide have been reported to reduce

long-term heart disease and mortality by a small amount, mainly through the sustained weight loss, but possibly also by reducing blood pressure.

Naltrexone–bupropion – is a combination of low doses of two drugs already well established for other indications. These interfere to prevent a compensatory reduction in effect by receptor downregulation at different points in the central control of appetite.

Lorcaserin – is a centrally acting serotonin reuptake inhibitor.

Adverse effects are more frequent with these drugs, but results also show sustained weight losses of 5–10%. As they have different mechanisms and different potencies, it has not been established exactly how they should be employed within an algorithm for drug treatment in obesity, or whether patients who appear unresponsive to one agent could do better with another. It is likely that anti-obesity drugs with other mechanisms will be developed, but providing evidence-based diet programmes will always be critically important for patient success.

Duration of drug treatment for obesity

Introduction of drug treatment for obesity should always be on a therapeutic trial basis, with a plan to withdraw the drug if it is ineffective. A formal ‘stopping rule’ (e.g. weight loss <3 kg at 3 months) can be appropriate to avoid unwarranted costs and exposure to potential adverse effects, as longer term success is unlikely. With newer, more expensive agents, further stopping rules have been proposed, for example <10 kg at 6 months and even <15 kg at 12 months, to ensure that they are only prescribed for people who derive major benefit. A difficulty is that individuals with lesser weight losses are those with the greatest difficulty controlling their weight, so stopping these drugs can lead to catastrophic future weight gain.

Withdrawal of effective anti-obesity drugs after weight loss and longer treatment usually leads to regain of weight towards that which would have been reached without treatment (which can be above baseline), as well as to parallel increases in cardiovascular risk factors, with a need for other drugs.

With orlistat, treatment might help patients learn to accept and adopt a much lower fat intake, but evidence is scarce. There is clinical trial evidence for safety and efficacy for up to 4 years (unusual for any drug), but regulatory authorities have in the past suggested that effective treatment should be withdrawn after 2 years (unusual for any drug controlling a disease). It is to be hoped that this regulatory inconsistency will not be repeated for new drugs. Whether treatment is stopped and restarted as a new 2-year course, or simply continued (technically off licence), patients need continued medical supervision and monitoring of risk factors.

Surgery

When obesity is extreme, complicated by severe secondary problems such as T2DM, sleep apnoea syndrome or benign intracranial hypertension, and some psychiatric complications, bariatric surgery offers the only realistic long-term solution for

many patients. Despite that, late weight regain is unfortunately the norm after all forms of bariatric surgery.

Guidelines for bariatric surgery suggest a lower BMI limit of 40 kg/m², or >35 kg/m² with medical complications, but existing coronary heart disease is usually considered a contraindication. With BMI >50 kg/m², individual risks and potential benefits should be balanced, and perioperative ventilation can be problematic. Preliminary use of a low-energy liquid formula diet and/or intragastric balloon is often used to shrink liver size and simplify the operation.

Three operations are in common use, with varying preferences: gastric banding, to restrict consumption of solid foods; sleeve resection of the stomach to reduce stomach size; and gastric bypass with Roux-en-Y. It is commonly believed that altered gut anatomy and mucosal food exposure cause weight loss through modifications in gut hormone release, specifically GLP-I secretion. The importance of these endocrine changes after surgery is disputed, and the main effect of bariatric surgery remains anatomical, with reduced energy consumption. The rapid improvement in glucose tolerance of individuals with diabetes after bypass surgery appears to derive entirely from the reduced food consumption.

All surgery incurs immediate perioperative mortality of 0.1–0.5% and a need for long-term medical and nutritional supervision. Chronic nutritional deficiencies are expected after bypass surgery because of malabsorption, and dumping syndromes (hypoglycaemic, hypovolaemic) are common. There is usually (but not always) rapid postoperative weight loss of 15–40 kg, and consequent improvements in multiple health outcomes; however, disordered appetites and eating habits remain, so some weight regain is usual after the first 2 years or so. Bariatric surgery has not been subjected to the same type of external scrutiny or demand for evidence as is required for new drugs, so surveillance programmes are underway to assess the long-term outcomes from current practices.

A liquid-based, low-calorie diet for 2 months before surgery reduces intra-abdominal fat and liver rigidity (from intrahepatic fat), making the operation easier. This is particularly important, to minimize trauma and risks, when laparoscopic methods are used. After surgery, a liquid diet for 3 months can improve the outcome by allowing healing before the stomach is stretched again, and providing a period for a well-planned food reintroduction programme. Unfortunately, many surgeons have neglected the need for close continuing postoperative support, and long-term follow-up evaluations have often been rather incomplete. As in many areas of surgery, there is need for much better evaluation of efficacy and safety of treatments before they are routinely offered to patients, along the lines pioneered for and by the drug industry. When bariatric surgery is considered for a metabolic problem, it is important to reflect that weight loss of 15–20 kg is usually sufficient, for example to achieve remission of type 2 diabetes – indeed in almost 9/10 cases (Lean et al. 2019 *Lancet*). This is possible for some patients with non-surgical methods, and might be achievable with safer, less radical surgical approaches. ◆

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